SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1908.

GENERAL PHYSICS.

366. *Reliability of Hair Hygrometer Records in Balloon Ascents.* **E. Kleinschmidt.** (Beiträge z. Physik d. freien Atmosphäre, 2. p. 99, 1906–1907. Abstract by **R. Süring.** Zeitschr. Instrumentenk. 27. pp. 378–380, Dec., 1907.)—The length of the hairs is found to be practically independent of the air pressure. In order to test the influence of temperature, humidity, intensity of air currents, &c., on the inertia of the hygrometers, the hygrometer was placed in a tube, 32 cm. in diam., through which air was sucked by a fan. For rapid rises, only one or two hairs should be used; bundles of hair respond less rapidly to increasing than to decreasing humidity. The velocity of the air current affects the lag but little, as does temperature between +20 and +5°; the lag becomes more pronounced at lower temperatures, and at −40° the hair hygrometer is not even qualitatively suitable—a fact already observed at Strasburg. Sudden fluctuations in humidity are very poorly recorded below −10°; slow variations are fairly registered down to −30°. Transitions from a cloud into a dry stratum, and *vice versâ*, are well indicated. The first kilometres should be passed through at the slowest possible speed; corrections can then be applied. In standardising the hygrometers, the author determines three points: at normal pressure, at reduced pressure in the cold, and again at the latter in an almost dry atmosphere (P_2O_5). H. B.

367. *Hydraulic Diaphragm Testing-Machines.* **A. Martens.** (Mitteilungen über Forschungsarbeiten des Vereines Deutsch. Ing. No. 38, 1907. Engineering, 84. pp. 861–862, Dec. 27, 1907. Abstract.)—Resumes the results of investigations into the limitations and possibilities of the hydraulic diaphragm measuring principle (*Messdosen*). The ratio between the width of unsupported portion of diaphragm and thickness of diaphragm should be small. In an example illustrated this varies from 3·3 to 3·1 in a box designed for a maximum load of 10 tons, with corresponding hydraulic pressure of 50 atmos. The diaphragm was of soft brass, 0·21 mm. thick, which is preferable to steel. All corners (usually three) in contact with the diaphragm should be slightly rounded off. It is possible to construct gauges of this type which will indicate accurately within ± 1 per cent. with hydraulic pressures of 100 atmos. or even more. The combination of a diaphragm box with two recording gauges, one of which is to be used as a check upon the other, is recommended. Upper stops are objectionable. Ordinary deviations as regards centreing and obliquity of loading introduce only very slight errors. Time-lag effects can generally in practice be treated as zero displacements; the scale should be adjustable as a whole and calibrated in degrees. The effect of changes of temperature was not investigated, but is expected to be unimportant. F. R.

368. *Electrically-controlled Testing Machine, and Torsion Tests.* **C. E. Larard.** (Inst. Mech. Engin., Proc. 8. pp. 705–741; Discussion, pp. 741–768, July, 1907. Engineer, 104. pp. 121–128, Aug. 2, and pp. 147–148, Aug. 9, 1907. Elect. Engineering, 2. pp. 262–266, Aug. 15, 1907.)—The machine described was made by Messrs. Buckton for the Northampton Polytechnic. It is of the single-lever type, giving a max. load of 150,000 lbs. and a max. moment of 400,000 in.-lbs. for torsion tests. The straining is obtained by hydraulic pressure, except for torsion, which is operated by electric motor, as also is the movement of the jockey weight. The max. rate of straining is 80 in. per min. for light loads and 12 to 15 in. for heavy loads. The jockey weight can be changed from 1,000 to 2,000 lbs. as desired, and weights of 1,250 lbs. may be suspended at the end of the beam. The vernier reads to 2¼ lbs. The movement of the jockey weight is controlled by a magnetic clutch on the shaft, which transmits motion from the continuously running motor through gear to the weight; the clutch is actuated through a make-and-break which is controlled by the movement of the beam. Further, when the beam approaches the bottom stop, the magnetic clutch is suddenly short-circuited, and simultaneously a solenoid is short-circuited, releasing a strap brake which promptly brings the weight to rest. Fine control and steadiness are obtained throughout the plastic stage in testing ductile materials. A chronograph is attached to the stress-strain recorder, marking intervals of time upon the diagram. Results of torsion tests of mild steel of diam. from ½ to 8 in. and length 4 to 12 in. are given. The form of the stress-strain curve beyond the yield-point (which at the high rate of straining used is not sharply marked) approximates closely to a parabola, or more accurately to the exponential law $d = a\, e^{kT/D^n}$, where d is the angle of twist in degrees per inch length, T the torque, D the diam. of specimen, a, k, n, constants, in a particular case 2·785, 1/2750, and 2·89 respectively. In the *discussion*, **J. Barr** stated that he had obtained a satisfactory automatic control by the use of a hydraulic movement for the poise weight and an electromagnetic control on the hydraulic valve. The **Author** referred to a testing machine with electrical automatic control, which had been used satisfactorily for over 9,000 tests. This is described in the report referred to in Abstract No. 956 (1907). F. R.

369. *Distribution of Pressure in Iron in front of a Penetrating Cutting-edge.* **A. Voigt.** (Verein z. Beförd. des Gewerbfleisses, Verh. pp. 448–502, Oct., and pp. 508–541, Nov., 1907.)—In the first part of this very lengthy and exhaustive investigation the work of previous authors is somewhat fully treated. In the course of this review the author calls attention to the probably valuable information which radiographs of metallic particles that are in different conditions as regards stress, might yield; and gives a reproduction of a radiograph showing the penetration of the rays from radium through sheet iron. The second part deals first with theoretical

attempts to give a general formula, notably that of Boussinesq as given in his "Applications des Potentiels" of 1885. The previous formulæ are then extended to the case of wide pressure surfaces. A formula is finally obtained which when simplified is—

$$\Sigma p = \frac{2\rho}{\pi}\left(\frac{zb/2}{(b/2)^2 + z^2} + \tan^{-1}\frac{b/2}{z}\right),$$

where Σp is the internal pressure for points inside the specimen which are on the xz (vertical) plane, and hence for which y (horizontal plane) $= 0$. Herein b is a very small width, ρ is the specific surface loading, z is the depth beneath the surface at which the pressure is required. An example is worked out showing the application of this formula, and a series of isobars given for the purpose of saving one the trouble of evaluating the expressions by direct calculation. Experiments which were carried out for the purpose of testing this formula are then described; these involve the application of a plane-faced rectangular (50 mm. × 5 mm.) hardened surface to the plane surface of the metal to be tested, and photographs are given showing the resulting deformation. The pressure at various depths below the surface was experimentally ascertained by means of small bore-holes (1·1 mm. diam., 19 mm. long) which were filled with wax: the amount of wax driven out as a result of the pressure being applied to the external surface was taken as a measure of the pressure at the depth of the bore-hole. Tabulated results of a test show that the difference between the pressures as estimated by the bore-holes, for a depth of 10 mm. below the surface of the metal, and those calculated from the above-given formula, amounted to 2·7 per cent. with a loading of 104·8 kg./mm.^{2}, and 5·9 per cent. with a loading of 118·7 kg./mm.^{2}. For a depth of 15 mm. below the surface the percentage difference was 4·8 for 107·6 kg./mm.^{2} and 8·0 for 120 kg./mm.^{2}. A very full bibliography gives references to over 140 papers on the subject. L. H. W.

370. *Hand-bending Tests.* **H. R. Sankey.** (Engineering, 84. pp. 829–831, Dec. 20, 1907.)—The hand-bending testing machine [see Abstract No. 806 (1907)] has been modified so that the records are now taken on a drum instead of on a disc, thus permitting of a more ready estimate of the energy expended in breaking; the results of tests made with the machine are given and discussed. Tests upon samples of the steels as rolled used in connection with the work referred to in Abstracts Nos. 1278 and 2217B (1904) showed that the max. bending effort varied closely with ultimate stress in tensile tests. The reductions of area in the two cases vary similarly, but that in the bending test is less than that in the tensile test. The number of bends required to produce fracture follows a somewhat similar law to the product of tensile elongation and reduction of area. There is agreement between the energy absorbed in the bending test and that absorbed in shock tests. In the case of three samples of steel containing 0·04, 0·3, and 0·5 per cent. phosphorus respectively, the hand-bending test gives much better indication of the brittle nature of the material than tensile tests [results of which were given by Stead in discussion referred to in Abstract No. 1711 (1907)] as regards (1) reduction of area, (2) number of bends compared with elongation × reduction of area, and (3) energy required to break specimen. F. R.

371. *The Notched Bar Shock Test.* **Ehrensberger.** (Zeitschr. Vereines Deutsch. Ing. 51. pp. 1974–1982, Dec. 14, and pp. 2065–2070, Dec. 28, 1907.

Report of Committee to the Deutsch. Verband f. Materialprüfung. d. Technik, Berlin, Oct. 5, 1907. Stahl u. Eisen, 27. pp. 1797–1809, Dec. 11, and pp. 1833–1839, Dec. 18, 1907.)—Three Charpy pendulum-type machines [see Abstract No. 950 (1905)] were made for this work, the maximum energy of blow available being 250, 75, and 10 kg.-m. in the three machines respectively. Most of the following conclusions are founded on numerous experimental results which are detailed in the paper. The energy absorbed in fracturing a series of carbon steels showed great variations having apparently no connection with elongation. A similar result was obtained with cast steels, and but slightly better agreement between shock strength and elongation occurred in various special steels. The curves have much more resemblance, however, for a series of nickel and nickel-chromium steels; in many of these the shock strength is remarkably high. Notches with sharp corners give lower values of the resistance to shock than rounded notches, this being more marked in brittle than in tough steels. The difference between radii of curvature of 2 mm. and 3 mm. is apparent in the results of tests. The energy absorbed per unit area of section of test-piece at notch increases with decrease of width of test-piece, other things remaining the same; and this is true for either sharp or rounded notches. Tests made at temperatures of +20°, 0°, −20° and −35° C. showed a tendency to reduced strength at lower temperatures. This is particularly marked in carbon steels, and not very apparent in some special steels. The paper concludes with a detailed specification which is proposed for adoption for tests of this kind. This refers to dimensions of test-pieces, and it is recommended that for general purposes the rounded notch be used. The temperature of testing should in ordinary cases be from 15° to 20°. Results should be expressed as energy absorbed per unit area ("spezifische Schlagarbeit"), and the general term proposed for toughness or resistance to shock is "Kerbzähigkeit." F. R.

372. *Strength of Rings.* (Engineer, 104. pp. 614–616, Dec. 20, 1907.)—It is shown that within the elastic limit the load W on a ring as a link of a chain is $\pi^2 r^3 f/4R$. The results of some experiments are given in which rings of 3 in., 4 in., and 6 in. diam. respectively were tested to destruction as chain links. The only method used for observing the commencement of plastic deformation was the recording of stress-strain diagrams; hence this point was probably well past before the loads mentioned below. The rings were made of ¾-in. diam. iron bar, welded; the weld being at one side in each case (*i.e.*, not in line of pull). The results were as follows:—

Diam. of Ring.	3 in.	4 in.	6 in.
Yield load calculated as above, tons	1·20	0·94	0·66
„ from stress-strain diagram, tons	3·0	2·0	0·7
Breaking load calculated as for two ¾-in. diam. rods	21	21	21
„ observed, tons	19·5	19·9	20
Position of break	clear of weld.	clear of weld.	at top.

It is concluded that the above formula may be used in design. The form $W = 0{\cdot}615 d^3 f/(D + d)$ is more convenient. D is internal diam., *d* the diam. of rod in inches, *f* the safe stress in tons per sq. in. F. R.

373. *Rupture of Materials under Combined Stresses.* **W. E. Williams.** (Phil. Mag. 15. pp. 81–87, Jan., 1908.)—The strength of rock-salt under

atmospheric pressure ranged from 400 to 900 gm./mm.², mean 600 gm., in the direction of an axis. Under fluid pressure of 1,000 atmos. the strength ranged from 500 to 1,000 gm.; means of specimens tested between 900 and 1,000 atmos., 724 gm./mm.². The results do not permit of exact generalisation, but are not in accordance with Poncelet's theory ("Rupture occurs when the greatest extension has reached a certain limit"). In the case of a hard-drawn aluminium wire there was no appreciable difference in the breaking stress with and without fluid pressure. At atmospheric pressure the average breaking strength was 18·6 kg./mm.²; at 700 atmos., 18·8 kg./mm.².
F. R.

374. *Working Stresses in Steel Structures.* **C. A. P. Turner.** (Eng. News, 58. pp. 626–630, Dec. 12, 1907.)—A general article. Taking 25,000 lbs. per sq. in. as the true elastic limit of mild steel, the author recommends that for working stress this should be reduced by 20 per cent. for possible inaccuracies of workmanship (*e.g.*, in length of members), and by 15 to 20 per cent. for variation in quality of material, and for weakening by connections and joints of built-up members, leaving 16,000 to 17,000 lbs. per sq. in. as safe static stress. The dynamic effect of moving loads must be allowed for in addition.
F. R.

375. *Design of Struts.* **W. E. Lilly.** (Engineering, 85. pp. 37–40, Jan. 10, 1908.)—A number of examples in which struts have failed by wrinkling are given. Tubes show this in a marked manner. When the length of the tube is less than the length of one wrinkle the ultimate load approaches the resistance of the material to compression. The length of a wrinkle varied as the square root of the area of cross-section. This leads to the formula $f = F/(1 + k\rho/t)$, where f is the limiting load, in lbs. per sq. in., on a column one wrinkle in length, F is the compressive strength of the material, in lbs. per sq. in., k is a constant ($\frac{1}{8}$ for mild steel, $\frac{1}{10}$ for wrought iron), ρ is the radius of gyration about a diam., and t the thickness of the circular cross-section. If the section approximates to a solid bar $\rho/t - 0{\cdot}5$ is to be used for ρ/t. Further experiments on square, triangular, and other sections show that the form of the formula is correct for these, but k has a particular value for each figure, which the experiments were insufficient to establish precisely. The formula is discussed in comparison with the Rankine-Gordon formula, and it is shown that the economic proportions (which give a column equally likely to fail by bending or wrinkling) are independent of F and E. It is considered that these principles were not appreciated in the design of the columns of the Quebec Bridge to whose collapse the disaster was due. F. R.

376. *Some Reinforced Concrete Tests.* **R. T. Surtees.** (Eng. Record, 56. pp. 661–663, Dec. 14, 1907.)—Steel embedded in concrete blocks which were exposed to water for 12 months, and then to acid vapour until the projecting ends of the steel were corroded away, was, save for a green colouring attributed to sulphur, unaffected in blocks with blast-furnace slag aggregate, but was corroded in blocks with clinker or brickbat aggregates, by reason of the porosity of these blocks. Some tests of water-tightness are described, blocks of concrete being submitted to pressure, and the leakage of water into them observed. The best results were obtained by keeping the concrete wet whilst setting. Compression tests of reinforced columns are described with photographs, and although the data given are incomplete, yet the superiority of hoops over spiral wrappings is demonstrated. The best result was obtained with an unreinforced column. These columns were 8 in. × 8 in. × 2 ft. 6 in. or 8 ft. or 4 ft. **F. R.**

377. *Tests of Full-size Compression Members.* **C. P. Buchanan.** (Eng. News, 58. pp. 685–695, Dec. 26, 1907.)—Gives detailed results of compression tests to destruction carried out on 19 full-size iron and steel bridge posts and chords, of lengths from 13 to 25 ft., made for the Pennsylvania lines west of Pittsburg. The principal data are summarised in the following table. No attempt is made to generalise upon the results, except a comparison with the crippling load formulæ of T. H. Johnson, viz., for iron, $p = 37{,}000 - 128\, l/r$, and for steel $p = 47{,}000 - 178\, l/r$; and those of J. B. Johnson, viz., for iron, $p = 30{,}700 - 0{\cdot}51\, (l/r)^2$, and for steel, $p = 39{,}900 - 0{\cdot}82\, (l/r)^2$, for the metals used.

Member.	Material.	Length, in.	Area, sq. in.	Section.	r.	$\frac{l}{r}$.	Elastic limit, lbs. per sq. in.	Yield-point, lbs. per sq. in.	Maximum, lbs. per sq. in.	Remarks.
Post	Iron	300	17·78		3·05	98	—	18,000	24,800	Buckled as a whole without marked local crippling.
Post	Iron	300	17·56	"	2·49	120	—	20,500	26,350	
Post	Steel	156	15·25	"	1·87	83	—	23,600	34,270	
Post	Steel	156	14·15	"	1·87	83	—	24,700	32,900	
Chord	Iron	$237\frac{1}{2}$	25·4		5·55	43	13,800	14,750	23,290	Failed in end detail.
Chord	Iron	$175\frac{7}{16}$	22·8	"	4·88	36	13,200	15,300	28,220	Failed in end detail.
Chord	Iron	$223\frac{3}{8}$	27·95	"	5·69	39	15,200	19,700	29,210	Failed in end detail.
Chord	Iron	$223\frac{3}{8}$	27·95	"	5·69	39	15,200	17,900	29,900	Failed in end detail.
Post	Steel	300	14·22		3·10	97	12,600	17,550	27,790	Outstanding legs of angles buckled near centre.
Chord	Iron	$289\frac{1}{2}$	28·38		6·34	46	16,700	18,500	26,200	Failed in end detail.
Chord	Iron	$289\frac{1}{2}$	28·20	"	6·33	46	15,950	19,500	26,230	Failed in end detail.
Chord	Iron	$163\frac{13}{16}$	27·46	"	5·65	29	17,300	20,000	30,770	Failed in end detail.
Chord	Iron	$242\frac{5}{16}$	27·28	"	5·80	42	20,150	22,000	28,200	Lower flanges buckled near centre and end detail showed signs of failure.
Chord	Iron	$190\frac{1}{2}$	21·78		4·71	40	17,200	20,650	26,260	Lower flanges buckled near centre.
Chord	Iron	249	30·81		6·51	37	17,000	24,300	30,300	Lower flanges buckled near end.
Chord	Steel	$297\frac{1}{2}$	29·36	"	6·44	46	25,500	28,900	30,640	Lower flanges buckled near centre.
Post	Steel	168	15·80		3·72	45	19,000	22,100	31,680	Crippled near centre.
Chord	Steel	249	32·11		7·29	34	22,600	26,500	31,980	Lower flanges buckled near centre.
Chord	Steel	249	32·16	"	7·20	35	18,700	23,300	33,950	Top flange buckled near end.

F. R.

378. *Tests of Reinforced Concrete Beams.* **A. N. Talbot.** (Univ. of Illinois, Engineering Experiment Station, Bull., 1907. Eng. Record, 57. pp. 24–26, Jan. 4, 1908. Abstract.)—The tests were made on beams 8 in. × 11 in. × 12 ft. span, and the centre of the steel reinforcement was 10 in. below the compression face, except where varied as stated for special reasons. In beams made of 1 : 2 : 4 concrete the steel failed in tension at calculated stresses slightly over the elastic limit, this being the cause of failure of the beams. Beams of 1 : 3 : 5½ concrete failed by tensile fracture of steel except in a few instances. All beams made of 1 : 5 : 10 concrete failed by diagonal tension at loads which appeared to be independent of amount or method of reinforcement. The average vertical shear stress developed was 68 lbs. per sq. in. It is not considered possible to found practical rules as to composition of concrete and proportion of reinforcement on these data. With 1·1 per cent. of reinforcement 1 : 2 : 4 beams carried from 10 to 15 per cent. greater loads than 1 : 3 : 5½ beams. Beams loaded (1) centrally, (2)–(5) at 2 points ⅛, ¼, ⅓, ⅜ of the span apart, and (6) at 3 points, all failed by tension in the steel, the calculated stress being rather over the elastic limit. The effect of 24 to 30 repetitions of a load, which proved to be from 50 to 85 per cent. of the load afterwards required to produce failure, was not very well marked, but was probably a reduced breaking load. It was expected that beams made with the reinforcing bars bent upwards in the two outer thirds of the length would bear a higher calculated vertical shear, but this was not borne out by the tests except in a few cases. [F. R.

379. *Stresses in Masonry Dams*. **E. Brown.** (Nature, 77. pp. 209–211, Jan. 2, 1908. Extract.)—This paper gives a review of a memoir on the subject by K. Pearson and A. F. C. Pollard. In a previous work Atcherley and Pearson criticised the action of engineers in ignoring the shear stress distribution, and in merely considering frictional stability as the criterion of safety as regards horizontal sliding. They demonstrated the existence of tension on some vertical sections of existing dams, using the common theory, and showed that the mid-third rule was not followed consistently throughout the design. In the present memoir the authors point out the conditions for a true beam problem, viz.: (1) The dimensions of cross-section are small compared with the length and with the radius of curvature; (2) true cross-sections, *i.e.*, sections perpendicular to the line of centroids, exist. As these conditions are not rigidly fulfilled in a masonry dam, the authors refuse to accept any results based on a simple beam analysis, and proceed to an endeavour to throw experimental light on the current mid-third theory, which they summarise as follows: (1) The dam shall not be subjected to tensile stresses. (2) This involves the line of resistance lying in the middle-third of horizontal sections. (3) Condition (2) has meaning solely on the assumption that the normal stresses are linear. (4) Linearity of normal stress involves the distribution of shearing stress being parabolic. The case of an infinitely long dam, or a dam of finite length abutting against rigid supports, is considered mathematically. It is assumed to be straight, to have a plane face at any batter, and a flank curved in any manner. Regarding it as a homogeneous isotropic material, the laws of elasticity lead to a differential expression of a stress function V, which function has to fit the boundary conditions of the dam, viz.: (*a*) On face where shear = 0, normal stress = water pressure; (*b*) on top and flank, where shear = 0, normal stress = 0; (*c*) on base, where the shear and normal stresses have their actual values. It is stated that (*c*) is generally ignored, and its existence prevents a mathematical solution being obtained. The object of the experimental work described was to determine the actual straining actions in model dams by direct measurement, and at the suggestion of the late B. Baker, jelly was adopted as the material of the dams. A mathematical investigation showed that with certain limitations an experimental "plate" dam without side supports can be used to test the distribution of horizontal shear by measurement of the distortion of lines ruled on its sides. Hence such "plate" dams were used. Only the existence of tension in the substratum and the manner of rupture were noted. Experiments were made on five models and the pressure applied to the face in several ways. As a result of the first set of tests, the authors maintain that, allowing for all irregularity in measurement and material, there is no approach to linearity of normal stress up to at least two-thirds, and probably up the whole height of dams of current form. The mid-third rule is, therefore, considered valueless as a stability test, and the success of engineers in building stable dams is attributed more to experience in choice of contours and to the use of a large safety factor than to any validity in the method of design. **H. M. Martin.** (Ibid. pp. 198–199, Jan. 2, 1908.)—Pearson's statement as to the distribution of the stresses due to the water pressure on, and the weight of, a dam appears to be opposed to the mathematical theory of elasticity; and in the present paper an attempt is made to prove mathematically that the stresses in the complete dam and in the slab are the same. **E. Brown.** (Ibid. pp. 221–222, Jan. 9, 1908.)—Brown does not agree with the conclusions drawn by Martin, and argues that the stresses in a thin slab, due to its weight and water pressure, must be different from those in an actual dam. The argument is based on the fact that a dam resembles in some measure a built-in beam. The mathematical solution of the theoretical case of a homogeneous isotropic dam, rigidly fixed at its ends and base, would be of interest, but it is questionable to what extent it would be applicable to practical conditions, in which dams are not homogeneous and isotropic, and foundations and abutments are not absolutely rigid. A. W.

380. *Flow of Liquids through large Conduits.* **H. Merczyng.** (Acad. Sci. Cracovie, Bull. 5. pp. 431–441, May, 1907.)—The results obtained in this fuller treatment of the subject dealt with in Abstract No. 374 (1907) are as follows: (i.) The motion of liquids at high velocities and for large conduits does not agree with either Poiseuille's formula or the binomial formula of Darcy. The curves given in the paper are not straight lines, as Poiseuille's theory demands, nor yet curves of the second degree, so that the loss of head, expressed as a function of the velocity, must give a formula more complicated than a binomial expression. (ii.) Extrapolation is of little use for high velocities in large conduits, as is shown by the fact that extrapolation from Darcy's tables for a velocity of 2·8 m./sec. through a conduit 0·5 m. diam. gives a loss of head of only 0·0167, while it is actually 0·0876. (iii.) Merczyng's results confirm those of Darcy and M. Lévy as concerns the effect of variation of diam.—the loss of head increases (for the same velocity) if the diam. diminishes. (iv.) The effect of sand in suspension in moving water has no effect on the general character of the phenomena, though the loss of head is greater than for pure water. For quantities of sand up to $\frac{1}{8}$ of the volume of the water (nearly $\frac{1}{3}$ the mass) the loss of head increases by only $\frac{1}{8}$ to $\frac{1}{10}$ that for pure water. (v.) The effect of curvature of the conduit is very pronounced. The liquid stream for large velocities and sections tends to take a straight-line motion. A. W.

381. *Recent Determinations of the Volume of the Kilogramme of Water.* **R. Benoit.** (Comptes Rendus, 145. pp. 1385–1389, Dec. 30, 1907.)—Measurements of the mass of the decimetre cube of water since 1821 vary between 1·000475 and 0·999750 kg., but Macé de Lépinay, Fabry, and Pérot, by the use of an interference method with a quartz cube, obtained values 0·999959 and

0·999979 kg. The International Bureau of Weights and Measures have proceeded for some years with a determination of the dimensions and volume of a solid of definite geometrical form and of the weight of water displaced by it. Three methods were applied by different observers to measure the dimensions of the solid: the method of contact was utilised in the case of three bronze cylinders, a combination of the interferential methods of Fizeau and Michelson in measuring a series of cubes of crown glass, and a transmission interference method was employed in the mensuration of two quartz cubes. The mean determinations by the three methods are 1·000029, 1·000027, and 1·000028 dm.^{3} for the volume of 1 kilogramme of water.

G. E. A.

382. *Density of Graphite.* **H. le Chatelier** and **S. Wologdine.** (Comptes Rendus, 146. pp. 49–53, Jan. 13, 1908.)—Graphite from eight different sources gave densities from 1·82 (Acheson) to 2·66 (Australian) when tested in mixtures of acetylene bromide and ether under vacuum. The results were no more concordant after purification with nitric acid followed by washing and drying, nor after treatment by the special method of purification indicated by Moissan, viz., fusion with KOH followed by washing with acids. Samples treated by the latter method and frequently compressed and broken up and re-compressed in a steel cylinder under pressures of from 2,000 to 11,000 kg./cm.^{2} had densities in nearly all cases of about 2·255, a few being as high as 2·262 and 2·264, compared with water at 4°. It is pointed out that as the dimensions of pores are of the same order as the dimensions of the flakes of graphite, 0·0001 mm., it is not to be expected that a sample under liquid can be freed from gas by vacuum, any more than a bubble of gas can be extracted from a capillary tube of this bore under similar conditions. F. R.

383. *Air-resistance.* **A. Becker.** (Ann. d. Physik, 24. 5. pp. 863–889, Dec. 31, 1907.)—This paper deals with the resistance experienced by spheres in currents of air and other gases. The first part discusses the Newtonian formula for the resistance and also that of Stokes. The rest of the paper describes experimental determinations of the resistance. Aluminium balls were used of various diam. (0·34 cm. to 0·79 cm.); air or other gas was passed through tubes of 2·4 to 3·8 cm. bore, the ball being at the centre of the tube, suspended from the arm of a special balance by a glass fibre. Thus the air pressure on the ball at different velocities could be determined. Numerous tables and diagrams of results are given. From these the author shows that the resistance W is given by the formula $W = k\eta rv + \frac{4}{3}\pi\gamma\delta r^2v^2$, where r is the radius of the sphere, v the gas velocity, δ the density of the gas, η is the frictional coefficient, and k and γ are constants. [See also Abstracts Nos. 1617 and 2080 (1901).] A. W.

384. *Collodion Membranes.* **S. L. Bigelow** and **A. Gemberling.** (Amer. Chem. Soc., Journ. 29. pp. 1576–1589, Nov., 1907.)—Collodion membranes in the form of bags or flat films, even of large size, are easily made, and they may be attached to supports more neatly and more perfectly than parchment paper. Dialysis occurs through them rapidly, but not so rapidly as through goldbeater's skin. The quantity of water passing through collodion membranes is nearly a linear function of the pressure at constant temperature. Calculation of a "pressure coefficient" of permeability at 25° showed that a change of 1 mm. in pressure causes a change in the volume of water passing equal to about 0·6 per cent. of the quantity passing under a pressure of 150 mm. of mercury. Under this pressure the quantity of water passing is not a linear function of the temperature; a rise of 20–30° is required to about double the amount of water passing per unit time. Different samples of collodion exhibit different permeabilities, but a change in pressure or temperature produces the same proportional effect for all the samples examined. Collodion membranes gradually diminish in permeability, but they can be used for from one to three months. T. H. P.

385. *Surface Tension by Jet Vibration.* **P. O. Pedersen.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 341–392, Dec. 20, 1907. Proc., Ser. A. 80. pp. 26–27, Dec. 9, 1907. Abstract.)—Among the large number of methods available for the determination of the surface tension of liquids the present method proposed by Rayleigh has great advantages. The principle is as follows: A jet of liquid issuing from an aperture *not circular* is executing transverse vibrations about its cylindrical configuration of equilibrium. Since the phase of vibration depends upon the time which has elapsed, it is always the same at the same point of space, and thus the motion is steady and the boundary of the jet is a fixed surface showing stationary waves. Measurements of the wave-length, velocity, and cross-section of the jet, together with the density of the liquid, afford the necessary constants for the calculation of the surface tension according to Rayleigh's theory of jet vibration. The method is free from every supposition respecting the angle of contact, and, what is even more important, the surface in use is continually renewed. Thus the surface tension can be determined before the surface is one-hundredth of a second old. In this research an "initial value" and a "stationary value" of the surface tension are recognised, the latter being the one involved in actual use, the former possessing the higher theoretical interest, while most methods of determination give some intermediate value. The author took special pains in making the jet aperture in order to ensure that the wave-form produced should be quite simple. For if waves of higher frequency are superposed upon the fundamental the measurement from crest to crest of the wave-form is not a true measure of the wave-length of the fundamental. This wave-length was measured from special photographs in which the jet itself is used as an optical image-forming system. The chief mean results for water are: (1) For ordinary tap-water, 74·33 dynes/cm. (2) For water two days after distillation, 74·31 dynes/cm. (3) For water distilled and kept a year in a stoppered bottle, 74·23 dynes/cm., with greatest and least values of 74·80 and 73·40 dynes/cm. For other liquids were obtained the following values: Toluol, 28·76; aniline, 43·00; aqueous solution of ammonia of densities 0·99080, 0·97921, and 0·95801, the respective values of surface tension 71·25, 68·02, and 64·69; solution of copper sulphate of density 1·05080, surface tension 74·27; diluted sulphuric acid of densities 1·08180 and 1·14816, surface tension 74·89 and 74·44 dynes/cm. respectively. E. H. B.

386. *Correction for the Force of Gravity at Cracow, San Francisco, and Dehra-Dun, reduced by a New Method.* **M. P. Rudzki.** (Acad. Sci. Cracovie, Bull. 8. pp. 937–958, Oct., 1907.)—Mountains or elevated masses of land, if sufficiently near to any point on the surface of the "geoid," exert at that point an attraction comparable to that of the geoid, and may sensibly affect either the direction or the intensity of the force of gravity at the point. If f' denote the correction required, f' may be calculated approximately by the aid of accurate maps showing the altitude of land near the point considered, and a knowledge, more or less exact, of the density of the rocks composing it. The subject had been treated by Helmert in a paper, "On the Method of Condensation." And the present paper is in part an answer to Helmert's. The author's mathematical method is in general as follows: He considers the geoid as approximately spherical. Then, to calculate the effect of elevated masses in the neighbourhood of any point, he employs the method of inversion, by which it is possible to substitute for the masses external to the geoid internal masses, according to the law $m' = ma/r$, in which m is an external mass at a point distant r from the centre of the geoid, a the radius of the geoid, and m' the mass which placed at distance $r' = a^2/r$ from the centre has at all points on the surface the same potential as m at distance r. By a somewhat long mathematical calculation he arrives at two formulæ: formula VII. applicable to small distances from the point considered, and VIII. to somewhat greater distances. As an example, let the point at which the correction for gravity f' is required be taken as pole, and the spherical surface be divided by parallels of latitude distant 1° from each other, and meridians at distances of 5°. Consider the quadrangle formed by the parallels 0 and 1, and the meridians 0 and 5°. The part of f' due to this quadrangle is by formula VIII.—

$$\frac{\gamma_m}{a^2}\,\frac{\partial_v}{\partial_m}\,\frac{z^2}{96}\left(\frac{1}{\sin 5^\circ}-\frac{1}{\sin 5{\cdot}5^\circ}\right),$$

in which γ_m is a constant, ∂_v is the mean density of the surface rocks, which is not subject to very great variations (from 2 to 2·7), and z^2 is the mean square of the altitudes for the quadrangle in question. By the use of this formula he obtains negative values for f' at Cracow, which is not near any elevated land, and at San Francisco, which is near the sea, while at Dehra-Dun, which is at the foot of high mountains, f' is positive, as appears by tables given for the three places respectively. S. H. B.

387. *Atmospheric Currents at very great Altitudes.* **C. C. Trowbridge.** (Monthly Weather Rev. 35. pp. 390–397, Sept., 1907. Contributed from the Phœnix Phys. Lab., Columbia Univ., N.Y., Sept. 5, 1907.)—Large meteors occasionally form long-enduring luminous streaks or trains, whose drift indicates the presence of various atmospheric currents at the high altitudes of these meteors, 72 to 104 km., average 88 km. The author examines the record by E. E. Barnard, W. F. Denning, A. S. Herschel, H. A. Newton, and others, of such trains from the years 1860 to 1870 and from other years. The luminosity is observed for several minutes, sometimes for more than an hour, and the streaks become peculiarly distorted, occasionally to the shape of the letters M or N. So far it would appear that as we pass northward from the temperate zone, the predominatory atmospheric current at altitudes of 50 or 60 miles is first to the N., then to the N.E., and finally in latitude 50 or 60° to the S.E.; local conditions, the position of continent and ocean, seem to be of influence. The streaks appear to be self-luminous and to give a band spectrum, and the phenomenon to be analogous to the afterglow of the electrodes of vacuum tubes. This afterglow is most persistent in the laboratory experiments of the author in a vacuum of 0·1 mm., which may be the air pressure at an altitude of 55 miles. The colour of the afterglow is greenish-yellow, the colour of the streaks yellow, green, or white. Meteor trains diffuse outward at a mean rate of 100 m./min.; the afterglow diffuses at about the same rate. These experiments promise to give us some clue as to the gas pressure and temperature at those altitudes. The particles of meteor trains are probably smaller than 0·00008 in., for which particles the Krakàtoa Committee of the Royal Society calculated a rate of fall, from a height of 15 miles, of 47 ft. per day; Kiessling has experimentally confirmed this rate. The particles of the meteor trains do not appear to fall, and are probably vapour clouds; the descent observed by H. A. Newton was probably due to downward currents. H. B.

388. *High Pressure over the Alps.* **A. v. Botzheim** and **J. Hann.** (Meteorolog. Zeitschr. 25. pp. 25–27, Jan., 1908.)—In summer, 1907, Botzheim was in a balloon over the Lake of Geneva. His barometer was out of order; two empty bottles took 50 and 60 sec. to fall from a height of about 2,000 m., and the balloon seemed to be weighted down. In two other ascents made on hot summer days at about 4 p.m. over the Lakes of Geneva and Neuchâtel, the balloons were drawn to the middle of the lakes, rising to 2,500 m., held there till the evening, and finally forced down into the water. The authors suggest that while warm air currents were rising on land, cold currents were descending in the air above the water and still more above the Alps. Synoptic charts as a rule show high pressure over the Alps and low pressure over the valley of the Po, and the Alpine high-pressure system seems to send out projections to any other approaching high-pressure area, while Lombardy and the warm Ligurian Sea seem to attract low-pressure areas. Over the glaciers thunderstorms are rare, and the high Alps (above 3,000 m.) received very little snow in 1906–7 when the lower districts had exceptionally heavy snowfalls. Hann remarks that he had already pointed out in 1887 that the Alps form a high-pressure district between the lows of the North and of the Mediterranean and Adriatic in the South. The depression in Lombardy could not last if the air did not descend again over the cold high Alps whose snow hardly ever melts. The thermal and dynamical conditions accentuate both barometric maxima and minima. For similar reasons southern Norway is, according to Mohn, under a barometric maximum in winter-time. H. B.

389. *Rainfall in the Philippines.* **M. S. Masó.** (Philippine Weather Bureau. Abstract by **R. de C. Ward** in Science, 26. pp. 760–761, Nov. 29, 1907.)—Observations have been made in 60 stations all over the islands, but with many interruptions. The general rainy season is June to Oct.; the eastern and northern coasts receive abundant rain in Nov. to Feb.; the winter rains come with the north-east monsoon; the spring and autumn rains are cyclonic. March to May are the driest months. Three rainfall zones are distinguished; the annual fall ranges from about 2,000 mm. to over 3,000 mm. H. B.

390. *Note on the Bore in Odawara.* **H. Nagaoka.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 10. pp. 210–212, Nov., 1907.)—The shores of Odawara and Kôzu are sometimes visited by destructive waves resembling tidal bores. They are not caused by local winds, but seem to be sensitive to distant storms not felt on those shores. Waves attaining tremendous heights—more than 9 m.—approach the shores for several hours or days, first increasing in amplitude, bringing walls of water several miles in length to the shore where they break like waterfalls. The sandy shore does not tremble, but the air is disturbed, and the doors of houses half a kilometre distant are shaken by the waves. Sometimes a portion of the wave-crest breaks into spray while a sharp crack is heard. This crack and the origin of the bores

remain unexplained. But the author has studied the waves with the limnimeter, and he shows that the problems can be attacked hydrodynamically. The height of the wave increases while the length diminishes, and as the depth is not uniform the waves are accompanied by several harmonics; the higher waves overtake the smaller waves as they approach the shore. H. B.

391. *Temperature and State of the Interior of the Earth.* **A. C. Lane.** (Science, 26. pp. 749–751, Nov. 29, 1907.)—This is a critical review of a book by Hermann Thiene, "Temperatur und Zustand des Erdinnern—eine Zusammenstellung und Kritische Beleuchtung aller Hypothesen." The philosophical faculty of Jena had offered a prize for such an essay, and Thiene's pamphlet of 150 pages is one of the contributions submitted. Thiene believes that the temperature gradient decreases with increasing depth; that the temperature maximum lies between 2,000 and 10,000° C.; that the theory of Kant-Laplace is established; and that the interior is a plastic anisotropic solid which would turn into a fluid if the pressure were removed. The reviewer criticises many points, especially also the scanty references to American geologists. H. B.

392. *The Sea-water of the English Channel.* **A. Chevallier.** (Comptes Rendus, 146. pp. 46–48, Jan. 6, 1908.)—Fifteen samples have been taken by Letalle between Dieppe and Newhaven on return journeys made on Oct. 23, 24, 25, 1907, and analysed in the Laboratoire d'Océanographie of the University of Nancy. The tests concern: Temperature θ *in situ*; density at θ; density reduced to 0° both after Thoulet and after the Hydrographische Tabellen (the two methods give identical figures); SO_3; halogens; and chlorine, the last one after Knudsen's Tabellen, starting from density at 0°. The water is colder near the coast—especially near the English coast—than in the open sea. The density increases noticeably as we go from Dieppe to Newhaven. This is ascribed to the influence of the water of the Seine, which is carried to the N.E. along the French coast; the SO_3 and the halogens vary in the same way, the agreement with the Cl-values is not so good. [Compare Abstracts Nos. 997 (1904) and 688 (1906).] H. B.

393. *Distribution of Blue-violet Light in Solar Corona.* **L. Becker.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 307–339, Dec. 19, 1907. Proc., Ser. A. 79. pp. 395–396, July 10, 1907. Abstract.)—The observations for this discussion were made at Koloa-es-Senam, Tunisia, during the total solar eclipse of Aug. 30, 1905, using an automatic apparatus giving ten exposures, governed electrically by a pendulum clock. Two cameras were employed, one with a Cooke triple achromatic lens of 3·5 in. aperture and 58·5 in. focal length, the other with a Ross portrait lens of 2 in. aperture and 12 in. focal length. Only the images given by the large objective are discussed in the present paper. Light was fed into both cameras by means of a cœlostat with mirror 8 in. diam. On the photographs obtained points are selected at which the photographic film shows the same degree of blackness, and their distance from the moon's limb are then measured. Tables are given showing the measured intensities at position angles differing by 15° round the limb, and the values plotted to show the curves of equal coronal intensity. C. P. B.

394. *Determination of Moon's Light with Selenium Photometer.* **J. Stebbins** and **F. C. Brown.** (Astrophys. Journ. 26. pp. 326–340, Dec., 1907.)—Commercial cells by Giltay and by Ruhmer were used. These consist of two wires wound close together in a double spiral about a flat insulator, the spaces on one face being filled with selenium which has been properly sensitised. The change of resistance of the cells for 1° C. varied from 18,000 to 27,000 ohms. The standard candle used was that of Max Kohl, burning amylacetate : diam. of wick 8 mm., height of flame 40 mm. The method of observation was to determine at what distance from the cell the standard candle would produce the same deflection as the light from the moon. Exposures at different distances from cell to candle were taken, and by graphical interpolation the required position was derived. Measurements were taken throughout a lunation, and the various light-intensities are plotted showing the change with moon phase, a correction being applied for atmospheric absorption. A notable feature is that there is evidence of the moon being brighter between first quarter and full than in the corresponding phase after maximum, this probably being due to the greater number of dark areas on the east than on the west half. The full moon appears to be approximately nine times as bright as the half-moon. It is shown that with the selenium photometer the central phase of a lunar eclipse could be determined within 1 min. of the predicted time. C. P. B.

395. *Temperature Control for Silvered Specula.* **H. D. Curtis.** (Astrophys. Journ. 26. pp. 256–262, Nov., 1907.)—In the course of the work of the D. O. Mills' Expedition to the Southern Hemisphere small focal changes, due to temperature, were found in the 37-in. Cassegrain reflector. Similar changes in large reflectors have been reported by Hale and others. In the Mills' instrument a progressive focal change of 15 to 25 mm. occurred in the first half of the night, always in the direction of increasing focal length, and was attributed to increase of concavity of the large mirror owing to fall in temperature. Neither improved ventilation, nor silvering of the back of the mirror proved of much avail. No accurate relation could be deduced between the focal ranges and the temperature records, the rapidity of change of temperature seemingly being of greater influence than the amount. Nor could it be established that the focus of the system after equilibrium is reached differs for different temperatures. The forthcoming report of the expedition will contain a discussion of the data by Wright. When the present author was appointed to continue the work it was decided to try the effect of artificial cooling of the primary mirror in the effort to do away with these focal variations. The method adopted is refrigeration by anhydrous ammonia. An ordinary commercial refrigerator is employed. It is one of the smallest size of self-contained refrigerating plants made by the Brunswick Co., and designated as a 100-lb. machine (its capacity being about equal to the melting of 100 lbs. of ice per day). The cooling coils are permanently attached to the telescope pier, insulated from it by layers of wood and felt, and are connected to the machine by strong iron piping. The machine itself is installed in a shed 48 ft. distant. When the mirror is being cooled the telescope is placed vertically, and a wooden case rolled into position so as to enclose the mirror, spectrograph, and lower half of the cube, which are then, by the addition of plugs, completely insulated from the outside air. Two electric fans blow the cold air from the coils so as to circulate around the mirror through holes in its cell and in the cube. At Cerro San Cristobal in summer a drop of 5° or 6° C. is usually experienced between 3 and 8 p.m., followed by a slow regular decrease till dawn. It is found best to start the refrigeration 2½ or 3 hours before sunset. After a fall of 5° or 6° C. the machine is stopped, and the case is removed about 40 min. before sunset.

By half an hour after sunset, as a rule, the mirror has adjusted itself perfectly to its focus for the night. In its control of focal changes this method of artificially cooling has been found quite successful. As a rule focal changes are entirely absent. Sudden changes in the night temperature may cause slight focal variations, but they are very small, rarely more than 5 mm. There is no evidence that the artificial refrigeration affects the silver surface of the mirror injuriously. A. E.

396. *An Absolute Scale of Photographic Magnitudes of Stars.* **J. A. Parkhurst** and **F. C. Jordan.** (Astrophys. Journ. 26. pp. 244-255, Nov., 1907.)—The method of determining photographic star magnitudes by measuring the opacity of the silver deposit on extra-focal images is said to be somewhat more accurate than other methods, and even were this not the case, it would still be useful for checking results. A scale, absolute in the sense of being derived from laboratory experiments, is furnished by determination of the effect on the plate, of lights differing in intensity by a known ratio. The authors' procedure is to employ a sensitometer box 8 × 4 × 5 in., divided lengthwise into 42 cells. The end next the illuminating source is covered by a metal plate pierced with holes opposite the centres of the cells. The photographic plate is placed at the other end. When the metal plate is uniformly illuminated the sensitive plate at the other end of the box will be blackened in squares corresponding to the cells, the opacity of the deposit depending on the amount of light admitted by the holes in the metal plate. To ensure uniformity of illumination pieces of ground glass are put between the source of light and the box. A Hartmann micro-photometer is used for determining the opacities, which are matched by means of a photographic wedge. Star images of different magnitudes on an extra-focal plate will be comparable with the effects of light passing through holes of different diameters. Various tests were applied to ensure consistent results. The temperature of exposure was varied from $-2°$ to $+17°$ C., and the duration from 10 sec. to 30 min., and various sources of illumination were tried, but none of these causes produced discordance in the results. Negatives on plate glass, however, gave much more concordant results than those on ordinary glass. The effect of a supplementary exposure (such as would arise from "sky-fogging") was also very noticeable, thin areas being more strongly affected than dense ones. Hence star plates must not all be reduced with the same absorption curve, but each plate with a curve corresponding to the amount of fog. From comparison of their measures of the Pleiades with those made by Schwarzschild, the authors infer that their method is capable of yielding results of extreme accuracy over a range of about two magnitudes on a single plate. Applications of the method to the Algol variables, U Ophiuchi, and R Z Cassiopeiæ, and to the suspected variable 32 Cassiopeiæ, are included in the paper. The last-named star appears not to be varying. The authors are at present engaged in investigating the relation between star colour and spectral type, and will soon publish provisional results. The strength of the K line is found to be an excellent criterion of the colour. In white stars it is absent or very faint, while in spectra called F in the Draper Catalogue the K and H lines are about equal. These F stars have a photographic magnitude about half a magnitude fainter than the visual. A. E.

397. *Explanation of Short-period Stellar Variability.* **F. H. Loud.** (Astrophys. Journ. 26. pp. 369-374, Dec., 1907.)—Development of an hypothesis independently noted by R. H. Curtiss [Abstract No. 18 (1905)] to

account for the light- and velocity-curves of W Sagittarii on the assumption that the system is pervaded by a resisting medium which enhances the brightness of that side of the star which faces the direction of motion. The special feature of this star was the discovery that the variation curves were so related that approach to the earth is accompanied by brilliancy above the average, and recession from it by comparative faintness. A recent collection of all the ten examples of this class of bodies, by S. Albrecht [Abstract No. 1471 (1907)], has brought out the remarkable fact that the above relation holds good throughout the list, and is apparently characteristic of the δ Cephei class of variables. In the present paper the author examines the separate cases to see how closely the relation is applicable to each in detail. A characteristic feature of the light-curve is its rapid rise before maximum, followed by a decline which occupies, on the average, double the time of increase, and often much more. Developing the theory, it is supposed that the primary is a dark body, and that the visible star revolving as the satellite has an asymmetrical area of incandescence, which is brought into view once during each revolution. An attempt is made to explain the slight secondary maximum often noticed in the light-curves of this class. C. P. B.

REFERENCES.

398. *Stability of the Steady State of Forced Oscillations.* **A. Stephenson.** (Phil. Mag. 14. pp. 707–712, Dec., 1907.)—A mathematical treatment. [See also Abstract No. 1451 (1907).]

399. *Artificial Dispersion of Fog.* **M. Dibos.** (Soc. Ing. Civ. France, Bull. 60. pp. 451–464, March, 1907. Eng. Mag. 33. pp. 633–634, July, 1907. Abstract.)—An account of some experiments, carried out at Wimereux, with an electrical method of dispersing fog which is somewhat similar to that proposed by Lodge. As applied on ships it was found that a cleared zone of 400-m. radius was obtainable by this means. L. H. W.

400. *Secondary Undulations of Oceanic Tides.* **K. Honda, T. Terada,** and **D. Isitani.** (Phil. Mag. 15. pp. 88–126, Jan., 1908.)—The full paper corresponding to Abstract No. 1304 (1907).

401. *Secular Perturbations caused by Mars on Small Planets.* **W. Dziewulski.** (Acad. Sci. Cracovie, Bull. 7. pp. 651–671, July, 1907.)—In continuation of previous work [Abstract No. 1546 (1906)] the effect of perturbations by Mars on several minor planets is examined and the results set out in tabular form. C. P. B.

402. *Secular Perturbations of Minor Planet Ceres arising from the Actions of Major Planets of Solar System.* **C. J. Merfield.** (Roy. Astronom. Soc., Monthly Notices, 67. pp. 551–560, 1907.)

403. *Large Eruptive Prominence.* **P. Fox.** (Astrophys. Journ. 26. pp. 155–156, Oct., 1907.)—The daily programme of observations with the Rumford spectroheliograph at the Yerkes Observatory includes a photograph of the prominences around the entire disc of the sun, using the "H" line. A series of thirteen plates taken on May 21, 1907, shows the progressive growth and decay of a very large eruptive prominence, and measurements are given showing the details. The maximum height reached was 431·8" of arc, corresponding to 316,900 km. C. P. B.

404. *Apparent Positions for 1908 of Stars of Newcomb's Catalogue.* **V. Balbi.** (Accad. Sci. Torino, Atti, 42. 15. pp. 678–698, 1906–1907.)

LIGHT.

405. *Optics of Moving Bodies.* **J. Laub.** (Ann. d. Physik, 25. 1. pp. 175-184, Jan. 17, 1908. Physikal. Inst., Würzburg, Nov. 18, 1907.)—Following up the electrodynamics of A. Einstein the author finds that the length of a rod as determined by an observer will depend only on the relative state of motion of the observer and rod, and will be completely independent of the nature of the medium in which the measurement is carried out. The Fresnel coefficient is also discussed. E. H. B.

406. *Relation of Doppler-effect in Canal Rays to Planck's Theory of Radiation.* **J. Stark.** (Phys. Zeitschr. 8. pp. 913-919, Dec. 15, 1907.)—The author starts with one of the results of Planck's theory of radiation, namely, that the distribution of energy amongst the radiations of a complex resonator takes place proportionately to the frequencies of the different radiations, and, assuming that a definite fraction (α) of the kinetic energy of a positive ion constituting a canal ray is converted into radiation of a particular frequency on impact with a stationary ion, obtains a relation between the radiation coefficient α, and $\Delta\lambda$, the width of the intensity minimum in the Doppler-effect. [See Abstract No. 57 (1907).] The presence of the intensity minimum he accounts for by considering that radiation is only produced when the time of impact or time of penetration of one ion through another is simply related to the periodic time of the natural vibration of the electrons within the ion. Hence a given line of a series is only emitted when the velocity or kinetic energy of the canal rays reaches a limiting value. The expression obtained shows that the greater the radiation coefficient the smaller is the width of the intensity minimum. The values of α are given for several cases, the results being determined from the measurements of the Doppler-effect. It is also pointed out that for velocities which are multiples of this exciting velocity a further excitation may be produced, and hence there may be several intensity maxima in the Doppler-effect, and that the widths of the intensity minima are as the square roots of the natural numbers. F. Paschen observed several intensity maxima [Abstract No. 1848 (1907)], but for want of suitable measurements it cannot be definitely stated whether this explanation of the phenomenon is correct. It is next shown that α is constant for the members of one series but differs for members of different series, both for the same and for different elements. For H_2, He, and the alkalies α is relatively large, and for O_2, CO_2, and N_2 α is relatively small. The presence of a line in the rest position ("ruhende Intensität") is accounted for by impact of the kathode rays, which, owing to their small mass, produce no appreciable velocity in the atom-ion. A radiation coefficient (β) for the kathode rays is calculated, and this is greater than α and is also greater for the first group of elements than for the second. The author draws a parallel between light-emission in the canal rays and positive column, on the one hand, and thermal emission on the other, and shows that the latter depends upon the same two radiation coefficients; and also that the smaller the radiation coefficients the higher must be the temperature of a gas before any given series is emitted. He also concludes that in the Bunsen flame the series lines of the alkali metals are produced by the impact of electrons with positive atom-ions. S. G. S.

407. *Physiological Errors in Astronomical Measures with Occulting Micrometers.* **L. Grabowski.** (Acad. Sci. Cracovie, Bull. 4. pp. 278–292, April, 1907.)—The author discusses the effect of stellar magnitude on results of observations in cases where the difference in position of two heavenly bodies has to be found from comparison of the times of their disappearance or reappearance at the edge of an opaque obstacle in the field of view of a stationary telescope. He finds that his own estimation of the time is affected by a magnitude equation of $-0{\cdot}24\ (10-m)$ sec. for disappearance, and $+0{\cdot}35\ (10-m)$ sec. for reappearance, respectively, m denoting the star's magnitude. Thus in his case the effect of personality is unsymmetrical, and therefore an erroneous result would be obtained by using the arithmetic means of the times of disappearance and reappearance for each star. A still greater error would be caused by using the disappearances alone, as advised by some authorities in the belief that it is only at reappearance that personality makes itself felt. The author advises every observer with an occulting micrometer to determine his own individual magnitude equation both for disappearance and reappearance of a star, and to apply the corresponding corrections in reducing observations. A. E.

408. *Visibility of Marine Night Signals.* **A. Broca** and **Polack.** (Comptes Rendus, 145. pp. 828–830, Nov. 11, 1907.)—With the aid of a special apparatus the authors have tested the physiological laws which govern the perception of colour in distant signals at night. A distant light which, when fixed by the eye, appears as a luminous point will apparently increase in size if the eye be slightly turned away from it. This fact is the same whatever be the colour of the light, but it is found that whereas certain colours are most easily perceived by central vision others are best seen by peripheral vision. Thus if a signal of doubtful colour is best seen by central vision it is red, while one which is clearer to indirect vision is either blue or uncoloured. H. W. P. Y.

409. *Transparency of Conducting Glass to X-rays and Ultra-violet.* **J. H. Gardiner.** (Röntgen Soc., Journ. 4. pp. 13–14; Discussion, pp. 14–15, Dec., 1907.)—Plates 1·5 mm. and 0·5 mm. thick were made from a block of Phillips' new glass which has the property of conducting electricity at ordinary temperatures [Abstract No. 324 (1907)]. The plates were polished, and their transparency to ultra-violet determined by means of a quartz spectrograph with electric spark between zinc-aluminium electrodes. The thicker of the two plates absorbed all radiations shorter than $\lambda 3400$, whilst the thinner one absorbed to about $\lambda 3000$. This glass is rather more transparent to X-rays than Jena U-V crown glass [see Abstract No. 538 (1905)]. The discussion was on the physical properties of the glass, which, although not a good conductor, conducts sufficiently to screen completely any electrostatic apparatus put within it. G. E. A.

410. *Sensitometry of Photographic Plates.* **R. J. Wallace.** (Astrophys. Journ. 26. pp. 299–325, Dec., 1907.)—In a former paper [Abstract No. 999 (1907)] the author referred to the evaluation of colour sensitiveness in photographic plates and the conditions suitable for uniformity of results. The present paper deals with the action of various baths for orthochromatic sensitising in order to produce as true a record as possible for the whole scale of colours from the ultra-red to the ultra-violet. Various combinations of the isocyanines were tried, and the effect on the colour sensitiveness is clearly shown by curves. Special mention is made of the necessity of close attention being given to development details for any tests requiring a series of plates for comparison depending on density of deposit. The author concludes that the best approximation to isochromatism is obtained by bathing such a plate as the "Seed 27" in a bath containing pinacyanol, pinaverdol, and homocol dissolved in water, alcohol and ammonia, and subsequent washing in alcohol; the whole of the operations being carried out at a temperature of 28° C. C. P. B.

411. *Flame Spectra obtained by Electrical Means.* **G. A. Hemsalech** and **C. de Watteville.** (Comptes Rendus, 145. pp. 1266–1268, Dec. 16, 1907.)—Two carbon electrodes are mounted in a glass bulb, and by means of a current of air passed through the bulb the vapours from the arc are passed into the burner producing the flame spectrum. The lower and positive electrode is hollow and is packed with the finely powdered substance under investigation mixed with some cement. Two mixtures are recommended: First, 3 parts B_2O_3 and 1 part of the substance fused together and poured into the cavity in the carbon; second, 2 parts of the substance and 1 part of asbestos and sodium silicate cement. The first is recommended for the investigation of the ultra-violet region, while the second is preferable for the visible region. If the carbon poles be replaced by iron rods and the vapours be fed into an arc between copper electrodes the arc spectrum of iron is obtained, while the spark spectrum is seen if the vapours be passed into the spark between copper electrodes. If the iron vapour be led into a Bunsen flame, then the iron flame spectrum is to be seen together with a strong continuous background; the latter disappears if the vapours be filtered through glass wool before they pass into the flame. E. C. C. B.

412. *Nature of γ-Rays and Röntgen Rays* **W. H. Bragg.** (Nature, 77. pp. 270–271, Jan. 23, 1908.)—The reply of Bragg to Barkla [Abstract No. 58 (1908)]. The latter has criticised Bragg's electric-doublet theory of the γ-rays; in his calculation he has assumed that the probable direction of motion of a neutral pair on emergence from an atom with which it has been entangled is independent of its original direction of motion. This assumption, according to the present author, is neither justifiable nor probable. Experiments are also given in support of the neutral pair hypothesis. According to the ether-pulse theory, if γ-rays pass through a thin plate so that the absorption is negligible, the amount of secondary radiation produced should be the same on both sides of the plate. On the neutral pair hypothesis it is quite possible, though not necessary, that the amounts on either side should be different. As a matter of fact there is a remarkable want of symmetry, and this appears fatal to the ether-pulse theory of γ-rays, and from their many points of similarity, of the Röntgen rays also. As the account of the experimental results is only a preliminary one, they are given here in brief. A cylindrical chamber is closed at one end with a double plate of carbon and lead and γ-rays are sent through this end. More secondary rays are produced in the chamber when the primary rays pass first through lead and then carbon than when the order is reversed, *i.e.*, the emergence rays are more numerous for carbon than for lead. If the other end of the chamber is closed, first with lead and then with carbon, it is found that lead gives more incidence rays than carbon. These incidence rays contain a large proportion of rays arising from the β-rays produced where the primary beam emerges from the double carbon-lead plate. The theory does not

exclude the possibility of ether pulses in γ-rays or in Röntgen rays; it is possible that it is these that have been the subjects of the experiments of Marx and Barkla. R. S. W.

413. *Production and Origin of Radium.* **E. Rutherford.** (Phil. Mag. 14. pp. 733–749, Dec., 1907. Paper read before the British Assoc. at Leicester, Aug., 1907.)—The main results of the paper have already appeared. [Abstract No. 1854 (1907).] The experimental details and theory of the methods are here given. An actinium solution is prepared, freed from radium as far as possible by the methods given below, boiled to expel all the emanation and then sealed. After a definite time the flask is opened, the emanation that has accumulated expelled by boiling and collected over water. This gas is then passed over drying tubes into an electroscope previously exhausted, and is tested after a further interval of three hours, when the active deposit is in equilibrium with the emanation, and therefore the rate of leak is changing slowly. The electroscope is standardised by means of the emanation from a solution of radium of known strength. If q_0 = amount of radium present initially, q = rate of growth of radium, then after the solution has stood for time t, the amount of radium present is $q_0 + qt$. Suppose the emanation removed after t_1 since the preparation of the solution, and the next test for it applied after a further interval t_2. If a constant quantity of radium is allowed to produce emanation for a time t, the fraction of the equilibrium quantity of emanation produced is $(1 - \epsilon^{-\lambda t})$. Consequently the amount of emanation present after a time of collection t_2 is proportional to $(q_0 + qt_1)(1 - \epsilon^{-\lambda t_2}) + q\int_0^{t_2}(1 - \epsilon^{-\lambda(t_2 - t)}) . dt$. The first part of this expression arises from the radium present at the time t_1, while the integral gives the emanation produced by the radium formed in the interval t_2. The quantity q is found constant throughout the time of the experiments. An actinium solution is freed from radium by precipitation with ammonium sulphide. This precipitates the actinium and leaves the radium in solution. The precipitate is dissolved in HCl and treated as described above. In 121 days the radium has increased 2·86 times. After this time the solution is treated with ammonia; most of the radium is removed by a single precipitation, while the rate of growth remains unaltered. This shows that while radium is soluble in ammonia the substance that produces it is not, but is precipitated with the actinium. In order to decide whether radium is produced directly by actinium or by some substance associated therewith two methods are used: (1) The actinium active deposit is tested; (2) the rate of growth is tested after the removal of actinium X. With the second of these methods, if radium is produced directly from AcB, the rate of production should be nearly proportional to the amount of AcX, since after a few hours the rapidly transformed products AcA and AcB are in equilibrium with it. Consequently if AcX is first removed the rate of growth of radium should be small at first and then gradually increase. Radium and AcX are removed by precipitation with ammonium sulphide and ammonia; it is found that the rate of growth is constant. Hence radium is not produced directly by AcB. A similar result is found by using method 1. By testing the α-ray activity it is found that ammonium sulphide removes part only of the actinium. The residue remains in the filtrates. After suitable treatment of these ammonia is added to precipitate the remaining actinium. This small precipitate contains more than three-quarters of the original actinium.

It is dissolved in HCl and tested for radium growth. No increase in radium content is found over 220 days. These results are best explained on the hypothesis that in ordinary actinium preparations there exists a new substance of slow change which is directly transformed into radium. It differs in chemical properties both from radium and actinium. There is no evidence whether this new substance is itself produced by actinium or whether it is merely associated with actinium in the same sense that barium always appears with radium. It is not unlikely that it is an intermediate product between uranium and radium. The slowness of its rate of change is inferred from the constant growth of radium in the solutions. R. S. W.

414. *Radio-activity of Lead and other Metals.* **J. C. McLennan.** (Phil. Mag. 14. pp. 760–779, Dec., 1907.)—While investigating the natural ionisation of air in closed vessels different observers have found that lead vessels impart an abnormally high conductivity to the gas. The question here investigated is whether this is due to a strong intrinsic radiation from lead or from some impurity contained therein. Vessels are made of lead obtained from different sources and of different ages, the surfaces are carefully cleaned, and the saturation current through the air inside is measured by an electrometer. The conductivity varies widely with the different samples of lead; the number of ions produced per sec. per cm.^{3} ranges between 28 and 160. This shows that the high activity of lead is due to the presence of radio-active impurities in different amounts. Using vessels made of different metals, lead included, freed from active impurities, it is shown that the different conductivities obtained arise from differences in the secondary radiations from these metals. Using a similar method, but shooting γ-rays from radium into the vessels, it is found that two-thirds of the ions produced are due to the secondary rays and the remainder to the γ-rays themselves in the case of lead vessels; with aluminium vessels these proportions are reversed. From the observations on the different lead vessels it is concluded that the penetrating radiation from the earth produces approximately 9 ions per sec. per cm.^{3} in free air. R. S. W.

415. *e/m for β-Rays.* **W. Kaufmann.** (Deutsch. Phys. Gesell., Verh. 9. 22. pp. 667–678, Nov. 30, 1907. Physikal. Inst. d. Univ., Bonn., Oct., 1907.)—Planck has questioned whether Kaufmann's experimental results can be used to decide between the various theories of the electron, as there is a possibility of the field between the condenser plates not being uniform owing to the presence of ions [see Abstract No. 1664 (1907)]. A variation in the field, on this account, of 10 per cent. would be sufficient to enable the Lorentz-Einstein relativity theory to account better for the results than the theory of Abraham. The author now calculates that the disturbing influence of the ions is of the order 10^{-8} instead of the 10^{-1} as required by Planck. R. S. W.

416. *Actinium Emanation.* **A. Debierne.** (Le Radium, 4. pp. 213–218, June, 1907.)—This paper gives a description of experimental determinations of the coefficient of diffusion of actinium emanation into the air. The value obtained was 0·112. From this the atomic weight of the emanation is found to be 70. The atomic weight of radium emanation, as determined by Curie and Danne, is 85; as determined by Makower, 85 to 99. Makower also found the emanation of thorium to have an atomic weight less that 99; Rutherford found it to be 101. So from the result given in the present paper it appears

that actinium emanation has an atomic weight less than that of either radium or thorium emanation. According to the theory of radio-active transformations all the above values should be two or three times greater. Possible explanations of this are suggested. A. W.

417. *Amount of Radium Emanation in the Atmosphere near the Earth's Surface.* **A. S. Eve.** (Phil. Mag. 14. pp. 724–738, Dec., 1907.)—The author has previously attempted to measure this by collecting the active deposit from a long wire at a high negative potential in a known volume of air, but the method is inaccurate on account of the fluctuations, the maximum being sixteen times the minimum [see Abstract No. 1788 (1905)]. Air is drawn by a water pump through H_2SO_4 and $CaCl_2$ and is passed through three iron tubes 87 cm. long and 4 cm. in diam., each containing 220 gm. of finely-divided charcoal. The tubes are placed in parallel, and about 8 c.cm. per sec. pass through each tube. Rutherford has shown that cocoanut charcoal absorbs the emanation. When the air has been flowing for several days, usually about 8·7, the iron cylinders are removed and heated to a dull red heat; the expelled gases are collected over water. These gases, about 15,000 c.cm., are then drawn through three small glass tubes in series, each containing 7 gm. of charcoal. The gases absorbed by these are driven off by heat and introduced into a previously exhausted electroscope. Two or three hours later the rate of leak is determined. A standard solution of radium is next prepared, is placed in a flask, and air bubbled through the solution, through drying tubes, and through the three iron pipes at the same rate and for the same time as before. Hence the amount of radium necessary to give the emanation in the atmosphere is found. Three determinations, made in Feb. and March, May, and July and Aug., give the radium required as 24×10^{-12}, 85×10^{-12}, 127×10^{-12} gm. R. S. W.

418. *Radio-activity of Sea-water.* **J. Joly.** (Roy. Dublin Soc., Proc. 11. 22. pp. 253–256, Jan., 1908.)—The radium in sea-water has been previously determined by Strutt [Abstract No. 1877 (1906)] and also by Eve [Abstract No. 454 (1907)]. Strutt's determination was from sea-salt, and, making a correction for an error in the calibration of his electroscope, gave $0{\cdot}0028 \times 10^{-12}$ gm. radium per gm. of sea-water. Eve determined the amount directly from mid-Atlantic water and also from Omaha sea-salt, obtaining the values $0{\cdot}0008 \times 10^{-12}$ and $0{\cdot}0006 \times 10^{-12}$ respectively. In the present paper the author describes tests of five samples of sea-water from different points round the Irish coast, which gave the following results:—

(*a*) Valencia, taken in March	$0{\cdot}0400 \times 10^{-12}$
(*b*) Isle of Man, taken in April	$0{\cdot}0386 \times 10^{-12}$
(*c*) 65 miles W. of Valencia, June	$0{\cdot}0314 \times 10^{-12}$
(*d*) 1·5 miles S. of Crow Head, June	$0{\cdot}0226 \times 10^{-12}$
(*e*) 20 miles W. of Bantry Bay, June	$0{\cdot}0393 \times 10^{-12}$

Such uniformity, the author says, could hardly be attained without a real basis for the results. Mid-ocean sea-water may not, however, be equally rich in radium. Samples are being obtained from many parts of the world, and the results for these will be compared with the above. A. W.

REFERENCES.

419. *Grating Photometer.* **W. B. v. Czudnochowski.** (Deutsch. Phys. Gesell., Verh. 9. 23. pp. 729–734, Dec. 15, 1907.)—Describes a photometer in which a grating of wire gauze is used to cast shadows on a matt surface. E. H. B.

420. *Diffraction and Reflection.* **W. v. Ignatowsky.** (Ann. d. Physik, 25. 1. pp. 99–117, Jan. 17, 1908.)—A continuation of the work of a previous paper [see Abstract No. 2024 (1907)] in which the phenomena are dealt with on the basis of Maxwell's theory. E. H. B.

421. *Contribution to the Theory of Dispersion.* **M. Planck.** (Phys. Zeitschr. 8. p. 906, Dec. 1, 1907.)—Mandelstam's calculations [see Abstract No. 1809 (1907)] are not considered to be correct, since the moment of a resonator has been treated only as a function of the time and not of its position. G. E. A.

422. *The Zeeman-effect in the case of Magnesium, Strontium, Calcium, Zinc, Cadmium, Manganese, and Chromium.* **W. Miller.** (Ann. d. Physik, 24. 1. pp. 105–136, Oct. 8, 1907. Extract from Dissertation, Göttingen.)—The author has examined the magnetic resolution of the spectrum lines of the above metals, using a large grating apparatus. The results of his observations are given in tables in the paper. E. C. C. B.

423. *Complicated Forms of the Zeeman-effect.* **W. Voigt.** (Ann. d. Physik, 24. 2. pp. 193–224, Nov. 12, 1907.)—This mathematical discussion is based on Lorentz's theory, and treats the cases of absorption and those of two, three, and four electrons coupled. [See also Abstract No. 3191 (1904).] E. H. B.

424. *Scattering of α-Rays.* **W. H. Bragg.** (Phys. Zeitschr. 8. pp. 886–887, Dec. 1, 1907. From the English.)—A criticism of (Frl.) L. Meitner's work. [See Abstract No. 1646 (1907).]

425. *Radium Emanation.* **W. Ramsay.** (Soc. Arts, Journ. 56. pp. 64–69, Dec. 13, 1907.)—A good account of the recent work of the author and his coadjutors on the subject. R. S. W.

426. *Radio-activity of the Waters of Plombières.* **A. Brochet.** (Comptes Rendus, 146. pp. 175–177, Jan. 27, 1908.)—These researches are held to confirm the author's earlier view that there is *no relation* between the radio-activity of the waters and their temperature. L. H. W.

427. *Radio-lead.* **B. Szilárd.** (Comptes Rendus, 146. pp. 116–118, Jan. 20, 1908.)—An account of methods that have been used to separate RaD, RaE, RaF from radio-lead. A strong light is found advantageous in some instances in bringing about the separation. R. S. W.

HEAT.

428. *Ignition Temperatures of Gaseous Mixtures.* II. **K. G. Falk.** (Amer. Chem. Soc., Journ. 29. pp. 1586–1557, Nov., 1907. Contribution from the Havemeyer Lab. of Columbia Univ.)—The author has determined the ignition temperatures of mixtures of hydrogen and oxygen; hydrogen, oxygen, and nitrogen; CO and oxygen; and hydrogen, CO, and oxygen by the adiabatic compression method [see Abstract No. 670 (1907]. The possible sources of error are discussed, and an expression is given for calculating the ignition temperature of any mixture containing hydrogen, CO, oxygen, and an inert gas. The reaction between hydrogen and oxygen is bimolecular, and that between CO and oxygen termolecular. The velocity coefficient per 10° rise of temperature is calculated to be 1·31 at about 800° and 1·18 at about 900° for the interaction of hydrogen and oxygen, and 1·24 at about 900° and 1·14 at about 1,000° for the reaction between CO and oxygen. The reactions between hydrogen and oxygen in presence of an excess of the former and between CO and oxygen in presence of an excess of the monoxide do not follow the simple laws of chemical kinetics, the excess of the hydrogen or CO exerting a negative catalytic influence. T. H. P.

429. *Thermally-excited Vibrations of an Atmosphere.* **C. V. Burton.** (Phil. Mag. 15. pp. 147–155, Jan., 1908.)—In Rayleigh's paper [*Scientific Papers*, vol. iii. p. 335], "On the Vibrations of an Atmosphere," the free vibrations of a gaseous mass in certain ideal circumstances are investigated. The author carries the investigation a step further by considering the vibrations which arise in like circumstances from fluctuating thermal conditions. The problem is to determine the pressure at a point after any given time, the initial thermal conditions being specified. It is assumed that in the free vibrations of the spherical sheet the relation between density and pressure follows the adiabatic law. In the case, therefore, of thermally-excited vibrations, the only appreciable transfer of heat is that arising from the heating effect of the sun and from radiation into space. To represent roughly the heating effect of the sun, it is assumed that during the day heat is being gained per unit mass of air at a rate proportional to the sine of the sun's altitude; while, day and night, heat is being lost at a rate proportional to the fourth power of the absolute temperature of the air. The results show that the degree of isochronism between the free periods of the spherical sheet of air and the periods of the thermal disturbing agency is so close that the author's assumption of no dissipation ceases to represent even approximately the actual conditions. The result indicates, however, a semi-diurnal barometric amplitude not widely different from the diurnal, provided equally favourable resonance conditions may be assumed. The greater prominence of the semi-diurnal period in practice could be accounted for if the agreement of period between free vibrations and disturbing agency were somewhat better for the second term of the author's solution than for the first. A. R.

SOUND.

430. *Vibrations of Liquid in a Cylindrical Vessel.* **K. Aichi.** (Mathematico-Physical Soc., Tōkyō, Proc. 4. 11. pp. 220–223, Dec., 1907.)—In the case of the vibrations of a membrane, whose boundary is approximately circular, the pitch of the vibration is nearly the same as that of a circular membrane of equal area. And if the area of a membrane be given, in the case of approximate circularity, the circle is the form of the boundary for which the pitch of the principal tone is the gravest. These two theorems have been proved by Rayleigh. The present author here shows that in the case of a vibrating liquid contained in a cylindrical vessel with a nearly circular section, the first theorem still holds good, but not the second. This peculiarity is due to the difference in boundary conditions in the two cases. In the latter it is the radial velocity which vanishes, instead of the displacement.

E. H. B.

431. *Vibrations in Conical Pipes.* **E. H. Barton.** (Phil. Mag. 15. pp. 69–81, Jan., 1908.)—Gives a mathematical theory of conical and quasi-conical pipes based upon the condensation instead of the velocity potential. This provides a treatment intermediate between the recondite mathematical treatises, on the one hand, and the mere statement of musical facts on the other. Explains, among other things, why a conical pipe, closed at the vertex and open at the base, should have the same pitch and the same complete series of harmonic tones as a parallel pipe open at both ends, whereas a parallel pipe if closed at one end falls in pitch about an octave and loses all the evenly numbered partials.

E. E. F.

432. *Speeds of Sound in Liquids.* **K. Dörsing.** (Ann. d. Physik, 25. 2. pp. 227–251, Feb. 7, 1908. Extract from Dissertation, Bonn.)—Using Kundt's dust-figure method the author finds values for a number of liquids and draws the following general conclusions: (1) The speed of sound increases with rise of temperature for water but decreases for other liquids. (2) In liquids which contain absorbed gases, the speed of sound increases with the quantity of gas absorbed. (3) In liquids which contain dissolved salts, the speed of sound increases with the quantity of salt dissolved. (4) In tubes the speed of sound in liquids, contrary to the case for gases, increases for a given strength of wall with decreasing radius; further, for a given radius the speed increases for increasing wall strength. (5) The decrease of sound speed of liquids in tubes may be ascribed almost exclusively to the elastic forces of the tube and of the liquid. Heat conduction and friction are without appreciable influence. (6) Vibrating liquid columns generate sympathetic longitudinal vibrations in the tube wall. Hence, to obtain Kundt's dust figures it is desirable to make the frequencies of the liquid and tube as nearly equal as possible. (7) In vibrating liquids, contrary to the behaviour of gases, the harmonic overtones distinctly assert themselves. (8) The ratio of the specific heats of ether is 1·376.

E. H. B

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

433. *Mass of Electrons.* **J. Stark.** (Deutsch. Phys. Gesell., Verh. 10. 1. pp. 14–16, Jan. 15, 1908.)—Criticises Kaufmann's reply [see Abstract No. 415 (1908)] to Planck's objection concerning his method of observing the deflection of β-rays [see Abstract No. 1664 (1907)]. To the plea that the electrostatic field would be disturbed by ionisation, Kaufmann replied by a calculation showing that such disturbance would be negligible. The author urges that Kaufmann mistakenly assumed the validity of Ohm's law, implied in Thomson's theory of the dependent current in gases. This is not valid for pressures of 1 mm. Kaufmann also neglected the slow kathode rays generated by impact on the condenser plates. **W. Kaufmann** (Ibid. pp. 91–95). E. E. F.

434. *Electric Theory of Matter.* **D. F. Comstock.** (Phil. Mag. 15. pp. 1–21, Jan., 1908.)—The complexity of the Zeeman-effect, and the relations between the wave-lengths of the spectrum lines, make it probable that if matter is an electrical system it must be much more complex than a system composed entirely of electrons separated by distances great in comparison to their size. It is therefore of interest to see whether any relations can be found between the mass of an electric system in general and any of its other properties. The author finds such a general relation, which is not only of considerable interest in itself, but also suggests other relations. The straightforward calculation of the mass of an electric system possessing any distribution of charge and any internal velocities below that of light presents considerable difficulties. For such calculation involves the use of the scalar and vector potential, and these are not effective instantaneously at all parts of the system. Any expression for the mass of the system calculated in this way will therefore involve terms which vary in an extremely complicated way with the internal velocities when these are not very small. The same is true with respect to the velocity of the system as a whole. The author gives a treatment which is not open to this objection, and bases it upon a consideration of the constraints of the system. A large plane air condenser moves in a direction perpendicular to the plane of its plates. If the condenser is charged there is obviously a transference of energy at a rate equal to the internal energy multiplied by the velocity of movement. The Poynting vector is, however, zero. The energy transfer is not through space in the ordinary sense, but is along the constraint which holds the condenser plates apart. The plate in the rear picks up the energy of the field, and after it has been transmitted to the forward plate by means of the constraint it is there set down again. On the other hand, when the condenser is moving parallel to the plane of the plates, there is no energy flow along the constraint, and the Poynting vector adequately represents the transfer of energy. So also in the case of a single moving electron the rate of transfer of energy is not given by the integration of the Poynting vector through all space, but differs from this by an amount corresponding to the energy flow along the constraints in the body of the electron. This does not mean that there is any energy associated with the constraints, for of course rigid constraints can neither absorb nor give out energy. There is no storing up but merely a transfer. The author proceeds to evaluate this rate of transfer, and after a lengthy discussion arrives at the following expression for the total momentum of any isolated purely electrical system moving with velocity v, which has on the average the same internal structure—

$$M = 2Wv/[V^2(1 + v^2/V^2)],$$

when W is the "transverse energy," or energy represented by the components of the electric and magnetic forces which are perpendicular to the velocity of the system. The mass of the system is then—

$$dM/dv = \frac{2}{V^2}\frac{W}{1+\frac{v^2}{V^2}}\left[1 - \frac{2v^2}{V^2}\frac{1}{1-\frac{v^2}{V^2}}\right] + \frac{\frac{4v}{V}\frac{dW}{dv^2}}{1+\frac{v^2}{V^2}}.$$

Neglecting terms of the second and higher orders, W has the same value as for $v = 0$, which from symmetry must be two-thirds of the total energy W_t. Thus mass $= 4W_t/3V^2$, which would apply accurately to ponderable bodies. Perhaps the simplest symmetrical system containing magnetic as well as electric energy is that formed by a great number of charged spheres moving in straight lines out from a common centre with velocities so small that the fourth and higher powers may be neglected. They are to be at distances from each other great in comparison with their size, and at equal distances from the common centre. If the system be now given the slow velocity v as a whole, the total momentum accompanying this motion may be determined. The result shows that the mass is $4/3V^2$. It may be concluded that, if ordinary material mass has an electromagnetic basis, such mass for slow velocities is proportional to the total electromagnetic energy-content of the body, and the laws of conservation of mass and energy become closely related, if not identical. Inertia is simply a manifestation of confined energy. The loss of mass consequent upon loss of energy is large enough to be detected in the case of radio-active changes. If we assume the disintegration theory of the elements, this loss of mass affords a ready explanation of the general small irregularities to be found in the list of atomic weights, and thus removes a serious difficulty from the path of the disintegration theory. For this loss of mass to take place, however, it is not necessary that the whole of the mass be electromagnetic. The author shows that if material mass be electromagnetic, and if lighter elements are formed from heavier ones through violent energy-changes, it follows that gravity acts between quantities of confined energy and not between masses in any other sense. Several speculations are indulged in as to the results of assuming gravitation between quantities of energy. Finally, the fundamental proposition is dealt with mathematically from an entirely different point of view, and the same result obtained. E. E. F.

435. *Discontinuities in the Motion of Electrons.* **G. A. Schott.** (Ann. d. Physik, 25. 1. pp. 63–91, Jan. 17, 1908.)—In order that an experimental decision may be arrived at as between the various theories of the electron, it is essential that the mass of an electron be defined in an entirely unambiguous manner. The author proposes a new method of arriving at the equations of motion of an electron, which, though not possessing the elegance and generality of Sommerfeld's method [Abstracts Nos. 574 and

2288 (1905)], is easier of physical interpretation, and allows of the full calculation of simple cases. Since every change of a motion involves a discontinuity, not of speed, but of acceleration and possibly of curvature of path, such discontinuities deserve special attention. The author uses the Liénard-Wiechert point law and Lagrange's theorem, and operates on a rigid electron with volume charge in rectilinear motion. He obtains for the scalar potential ϕ and the vector potential **a** of a point element the series—

$$\phi = \sum_{n=0}^{n=\infty} \frac{(-1)^n}{n!\, c^n} \frac{\partial^n R^{n-1}}{\partial t^n},$$

$$\mathbf{a} = \sum_{n=0}^{n=\infty} \frac{(-1)^n}{n!\, c^n} \frac{\partial^n}{\partial t^n} \left(\frac{\mathbf{v}}{c} R^{n-1} \right).$$

These series lead in general to the Abraham-Sommerfeld expressions for those parts of the mechanical work which depend upon the speed and the acceleration, and for the radiation-pressure. But these series require additional potentials in order to fulfil the initial conditions. The dispute between Sommerfeld and Lindemann is resolved by the consideration that Lindemann's modification of the potential equation only applies to the original stages of motion, whereas Sommerfeld's does not apply to those stages. All initial stages involve a discontinuity, and therefore an additional potential. But this potential only yields additional terms for the force if speeds greater than that of light are possible, and even then only the radiation-pressure is affected. The usual expressions for the mass apply strictly, as in Lorentz's theory, whether the electron is rigid or not. If speeds beyond light are possible, every sudden change of acceleration or curvature of path produces afterwards a change in the radiation-pressure. The latter can only be fully calculated when the previous history of the electron is known, since it depends upon waves previously emitted owing to sudden changes. Discontinuities of higher orders, as of the twist of the path, produce no change either of mass or radiation-pressure, but simply changes of terms of higher order. All these conclusions only apply when the electron has left the scene of the discontinuity, *i.e.*, when it has become displaced from its position of rest by several diameters. E. E. F.

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436. *Theory of Magnetism.* **G. A. Schott.** (Phil. Mag. 15. pp. 172–198, Jan., 1908.)—Spectroscopic phenomena throw much less light on the structure of the average atom than has hitherto been supposed. The phenomena of magnetism may yield more information. An assemblage of mutually independent electrons, revolving in elliptic orbits, give on the average no magnetic moment at all. They would give moments if subject to irregularly distributed impulses (Voigt), or if their orbits continually diminish in area (Thomson). But neither of these hypotheses is necessary; for a system of electrons in orbital motion must group themselves in rings if their radiation is to be sufficiently small for permanence; and a ring, as opposed to a system of independent electrons, possesses magnetic properties. On the whole, the most satisfactory system is a positive body containing several rings of electrons (Thomson's model). The author shows that for a sphere of given mass and radius, and for a ring of a given number of electrons and a given velocity, there is a critical radius, such that the system is paramagnetic when the radius of its ring is larger, and diamagnetic when smaller. Thus the system of a sphere and a single ring can account qualitatively for both paramagnetism and diamagnetism. There are four limiting cases: (1) A sphere of infinite mass, and a ring of very few electrons; (2) a sphere of infinite mass, and a ring of very many electrons; (3) a sphere whose mass is purely electromagnetic, and a ring of few electrons; (4) a sphere with a purely electromagnetic mass, and a ring of very many electrons. The following general conclusions are drawn: (1) In similar systems both paramagnetism and diamagnetism, as measured by the specific moment, are proportional to the volume; (2) increasing the mass of the sphere increases paramagnetism, and diminishes the critical radius; (3) increasing the radius of the ring increases paramagnetism; (4) increasing the number of electrons in the ring diminishes paramagnetism and increases the critical radius. Comparing the formulæ with observed susceptibilities, it appears that no single-ring system can be diamagnetic unless the number of electrons in the ring is less than 8. This number obviously does not give sufficient margin for the large number of diamagnetic elements known. When there are several rings, their moments cannot be simply added up. They link with each other in various complicated ways. In any case, magnetic properties, like atomic weight and atomic volume, probably depend upon the number and arrangement of the electrons in the atom. E. E. F.

437. *Atmospheric Radio-activity.* **K. Kurz.** (Ann. d. Physik, 24. 5. pp. 890–930, Dec. 31, 1907. Extract from Dissertation, Giessen.)—This paper gives a description of experiments with Ebert's, Gerdien's, and Elster and Geitel's apparatus on the effect which the radio-active substances of the atmosphere have on various measurements of atmospheric electricity. The results of the investigations are summarised as follows: (1) The results of measurements of the electric conductivity, &c., of the air in which a leaf-electroscope is used with charged ionising bodies, are in general influenced by the solid radio-active substances of the atmosphere. With negatively charged ionising bodies there is a deposit of solid radio-active matter, giving a greater divergence of the Al-leaves than would be expected for the natural proportion of positive ions. Under certain circumstances a similar effect with tube-condensers can occur for positively charged ionising bodies owing to the radio-active matter deposited on the inside of the outer cylinder. With Ebert's aspiration apparatus the number of ions is generally about 4 per cent. too large, the ionic velocity being therefore about the same amount too small. With Gerdien's apparatus there is under normal conditions equal potential-fall for positively and negatively charged ionising bodies. With Elster and Geitel's apparatus the magnitude of the above effect cannot be determined numerically. (2) The condition which determines the magnitude of the effect is whether the apparatus works with saturated or unsaturated current. In an apparatus working solely with "free" current the effect is practically absent. (3) The product of the specific conductivity and ionic velocity is the same for the positive and negative ions. [See also Abstract No. 1886 (1907).] A. W.

DISCHARGE AND OSCILLATIONS.

438. *Emission of Negative Ions from Glowing Metal and Oxides.* **F. Deininger.** (Deutsch. Phys. Gesell., Verh. 9. 22. pp. 674–680, Nov. 30, 1907. Ann. d. Physik, 25. 2. pp. 285–308, Feb. 7, 1908. Communication from the Physikal. Inst. d. Univ., Erlangen.)—The emission of negative ions from heated metals and from glowing oxides follows the well-known Richardson formula $a\theta^{\frac{1}{2}}\epsilon^{-b/\theta}$, but the current from the oxides is much more copious than from the metals. According to one view the increased emission is caused by the oxide decreasing the discontinuity of potential at the surface of the metal, and so lessening the work required to pull out an ion. According to another view the ions actually come from the oxide itself. The current is measured from rods of Pt, carbon, Ta, and Ni when bare and when covered with lime. The temperature is also taken by a thermo-couple. Each rod is found to give a characteristic curve for the temperature-current when it is bare; when covered with lime the four curves obtained coincide. It is therefore concluded that the ions come from the lime. R. S. W.

439. *Ionisation of Liquid Dielectrics through Radium Rays.* **G. Jaffé.** (Ann. d. Physik, 25. 2. pp. 257–284, Feb. 7, 1908.)—The current is found to consist of two parts, one obeying Ohm's law, the other giving a saturation value. The slow decrease in the conductivity which is observed after the ionising agent is removed cannot, according to the author, be accounted for by the small velocities of the ions. R. S. W.

440. *Magnetic Effect of Kathode Rays.* **E. Klupathy.** (Ann. d. Physik, 25. 1. pp. 31–47, Jan. 17, 1908. Physikal. Inst. d. k. Ungar. Univ., Budapest, Sept., 1907.)—Describes a method of proving that a beam of kathode rays exerts a magnetic action corresponding to that of a straight conductor carrying an equal negative current. Hertz attributed his negative result to the kathode rays being a wave-motion. J. v. Geitler attributed it to an opposite current passing along the walls of the tube. Success is only made possible by using a very sensitive magnetic system which is not sensibly affected by sudden periodic changes of field. This is obtained by suspending a thin vertical bar magnet by a horizontal beam, suspended in turn by a quartz fibre, and bearing a counterpoise at the other end. The pole of the magnet is brought close to a horizontal kathode-ray tube. The effect obtained indicated a current of 6 microamps., whereas the electrical data indicated 4 microamps. This is a sufficiently close agreement. The author also studied the kathode rays from Wehnelt's oxide kathodes, and was surprised to find no magnetic action in them. This may be due to the low speed of the rays. E. E. F.

441. *Positive Rays.* **A. Bestelmeyer** and **S. Marsh.** (Deutsch. Phys. Gesell., Verh. 9. 24. pp. 758–763, Dec. 30, 1907. Physikal. Inst. d. Univ., Göttingen, Dec. 7, 1907.)—Lilienfeld has described experiments tending to show the presence of positive electrons in a discharge tube [Abstracts Nos. 456 and 1071 (1907)]. The authors show that if kathode rays are shot through a hole in a diaphragm a luminous ray may be seen on the rear side; if the kathode rays are deflected by a magnet there is a remainder which may be deflected electrostatically. The direction of deflection shows that the ions are positively charged. R. S. W.

442. *A Gas Generated from Aluminium Electrodes.* **R. v. Hirsch** and **F. Soddy.** (Phil. Mag. 14. pp. 779–784, Dec., 1907.)—v. Hirsch has shown that when kathode rays are generated by means of an influence machine in pure gases, the relation between the pressure and the voltage is $p^2V =$ constant. This does not hold for mixtures. The constant depends in some way on the molecular weight of the gas. During discharge a gas is evolved from the electrodes, if these are aluminium; by repeated pumping out and continued evolution of this gas a value of p^2V is found, which is constant, but cannot be identified with that of any known gas. English-made bulbs do not give the gas, those from Germany do. This is finally traced to the difference in the electrodes. If English aluminium is smeared with sodium the gas is constantly evolved. It is suggested that the electrodes, containing a trace of sodium, decompose water and become charged with hydrogen. The unknown gas may be a modification of hydrogen, like ozone is of oxygen. Very pure aluminium electrodes cause the discharge to pass with difficulty and irregularly. This may explain some of the difficulties besetting X-ray bulb manufacturers in this country. R. S. W.

443. *Wehnelt Kathode in a High Vacuum.* **O. W. Richardson, F. Soddy.** (Nature, 77. pp. 197–198, Jan. 2, 1908.)—Richardson thinks that the experiments of Soddy [Abstract No. 108 (1908)] do not necessarily contradict the conclusions that either Wehnelt or he has reached respecting the emission being electronic. Wehnelt's experiments were carried out with much smaller currents: when the currents are of the order 1 amp./cm.^{2} ionisation in the gas also plays a part, as is shown by the glow round the kathode. When the pressure of the gas falls below the value required to maintain this glow under the assigned conditions there will be a sudden drop in the value of the discharge current. This appears to be what Soddy has observed. Soddy thinks the action of the gas is the same whether a Wehnelt or other electrode is used. There appears to be a definite pressure at which the conductivity is a maximum in every case. R. S. W.

444. *Photo-electric Fatigue.* **Mme. M. Sadzewicz.** (Acad. Sci. Cracovie, Bull. 5. pp. 497–498, May, 1907.)—An account of an investigation in the laboratory of the Physical Institute at Léopol on the so-called photo-electric fatigue of metallic plates accompanying Hallwachs' phenomenon, and consisting of the decrease of the photo-electric current with the time of the illumination of the kathode by ultra-violet rays. A galvanometric method was employed, and it was found that the fatigue increased with the time but not proportionally to the time. At first it is more rapid and then decreases. The degree of the fatigue does not depend on the initial value of the current, on the electric state of the plate during illumination, nor on its photo-electric sensitiveness. It is thus not an electric phenomenon properly so-called, and is not closely connected with Hallwachs' phenomenon. The fatigue does not consist merely in the change of the physical qualities of the metal surface under the action of light (corrosion); neither is the absorption of ozone on the surface of the metal the principal cause of the fatigue, for it occurs when the plate is surrounded by various gases. But the state of the atmosphere around the plate affects the phenomenon very much. On removing partially the atmosphere and covering the plate during illumination by a layer of quartz fatigue scarcely takes place. Moreover, when a current of gas is made to pass through the photo-electric cell the fatigue is less than in the same gas in repose. An atmosphere of surrounding gas is an indispensable condition of the phenomenon. The ultra-violet rays are an important factor and a favourable one, but are not indispensable, for fatigue can take place, though feebly, in the dark. The phenomenon takes place in the limiting layer between the surfaces of metal and gas. J. J. S.

445. *Frequency of the Light producing the Photo-electric Effect and the Velocity of the Ions.* **A. Joffé.** (Akad. Wiss. Wien, Sitz. Ber. Math. Phys. Kl. 87. 8 1907. Ann. d. Physik, 24. 5. pp. 939–940, Dec. 31, 1907.)—E. Ladenburg, from his experiments, has found that the frequency of the light has an influence on the velocity of the emitted ions [Abstract No. 1891 (1907)]. This velocity was measured by finding the potential to which the plate must be raised to stop the emission. The relation given was $n = a\sqrt{P}$, n being the frequency and P the potential of the plate. Joffé points out that a linear relation between n and P is equally well satisfied, and hence that the observations support the theory of Einstein [Abstract No. 1228 (1906)]. R. S. W.

446. *Light-electric Effect on Gold-leaf.* **H. Rubens** and **E. Ladenburg.** (Deutsch. Phys. Gesell., Verh. 9. 24. pp. 749–752, Dec. 30, 1907. Physikal. Inst. d. Univ., Berlin, Nov., 1907.)—Some years ago Hallwachs showed that the light-electric effect could be obtained with a silvered quartz plate when the light was incident through the quartz. This can be explained in two ways: either the light passes through the silver and produces the effect at the back surface, or the light is absorbed by the silver, produces electrons in the metal, and these have velocities great enough to carry them out through the rear side. A similar effect is now found with gold-leaf. The ratio of the effects in front and behind is 100 : 1; the fraction of the ultra-violet light transmitted, photo-electrically measured, is 1/1000th. The second hypothesis seems therefore the most probable. Control experiments show that the results are not due to reflection of light from the walls of the tube. The effect gradually increases with time; this is due to a spluttering and consequent thinning of the gold-leaf. R. S. W.

447. *Electrical Oscillations on a Metallic Cylinder surrounded by a Dielectric.* **K. Aichi.** (Mathematico-Physical Soc. Tōkyō, Proc. 4. 11. pp. 224–227, Dec., 1907.)—The author considers that in the problem of a metallic cylinder surrounded by a dielectric, treated by J. J. Thomson in his "Recent Researches" (p. 347), the semi-convergent expression taken by the latter is too slowly convergent for small values of x. Taking another, and, according to the author, more suitable expression for small values of the root (x), the result is arrived at that the vibration has a period $5{\cdot}14 \times \pi a/V$, and after one complete vibration the amplitude is only $\epsilon^{-3{\cdot}43\pi}$ (or 1/50000 of its initial value). Thomson's corresponding values (*loc. cit.*, p. 349) are $8{\cdot}1\pi a/V$ and $\epsilon^{-1{\cdot}74\pi}$ (= 1/250 about). [This result is of interest in view of Fessenden's proposal to use a metal cylinder immersed in a dielectric, as a transmitting aerial in wireless telegraphy.] L. H. W.

448. *Electric Waves through Thin Plates.* **W. R. Blair.** (Phys. Rev. 26. pp. 61–97, Jan., 1908.)—By means of a Righi oscillator with parabolic reflectors beams of electric radiation were sent through thin plates of dielectrics including thin layers of water, and were dealt with by a Michelson interferometer. The chief results of the experiments and the theory developed in connection with them are as follows: (1) The variation in intensity of both the transmitted and reflected energy is observed to be in accord with the formulæ developed for similar optical effects as in the text-books. (2) The index of refraction of water is determined to be 8·92, no indication being observed of the anomalous dispersion found by Drude in the vicinity of the frequency 1·5 × 10^9. (3) The change of phase per unit thickness of dielectric due to passage of electric waves through thin plates is not a constant, but the variations both in phase and intensity with their films and prisms may be explained as interference phenomena due to multiple internal reflections. (4) This variable change of phase manifests itself with a thin prism as an apparent variation in the thickness of the prism and consequent variation of its refracting angle at different actual thicknesses. This seems to render unreliable all determinations of indices of refraction made with thin prisms, including the work of Kundt on metals and that of Lampa on water. (5) The text-book formulæ used for computing the index of refraction of a substance from data taken with either the interferometer or the spectrometer will not apply in the cases of thin films and thin prisms, but must be supplemented by the interference formulæ. E. H. B.

449. *Increasing the Regularity of Discharges in Oscillatory Circuits.* **W. Eickhoff.** (Phys. Zeitschr. 8. pp. 923–924, Dec. 15, 1907.)—Points out that the regularity of the discharge across a spark-gap in condenser circuits can be considerably increased by connecting a metal wire to the negative electrode of the secondary, the other end of the wire being pointed and brought round so as to face the positive spark-ball. The sparking voltage is said not to be altered by this arrangement. [Compare Bowlker, Abstract No. 886 (1905).] L. H. W.

450. *The "Brushing" of Condensers.* **G. Benischke.** (Phys. Zeitschr. 8. p. 924, Dec. 15, 1907.)—Referring to Eickhoff's experiments and to his adoption of Fleming's explanation by which the variability of the capacity of condensers would be due to "brushing" [see Abstract No. 1898 (1907)], the author points out that he has already dealt with the case of such a shunting of the condenser, and has shown that with a variable resistance shunt (such as was present in Eickhoff's work) the current maximum is both displaced and diminished [Abstract No. 1780 (1906)]. A mere increase of capacity causes no diminution in the current amplitude in a simple alternate-current circuit having pure capacity and self-inductance. L. H. W.

451. *Undamped Electric Oscillations.* **O. M. Corbino.** (Elettricista, Rome, 6. pp. 829–830, Dec. 1, 1907.)—A shunt motor constructed with laminated iron, exposed to an alternating sine p.d. at its terminals, behaves like an inductive resistance whose inductance may have a negative value. It is therefore equivalent to an inductance in series with a capacity. For a certain velocity the equivalent inductance and capacity are independent of the speed. Upon this principle a new method of obtaining permanent electric oscillations is based. It is done by coupling a series dynamo with a shunt motor, and requires no condenser. The dynamo is equivalent to an inductive conductor with negative resistance, and the motor is equivalent to a conductor endowed with resistance, self-inductance and capacity, all in series. If the negative resistance balances the positive resistance, there is no damping, and the whole system will emit oscillations having a proper period of their own and a constant amplitude. The motor behaves as a condenser when rotating in the same direction. This case is different from Leblanc's oscillating motor and from Swinburne's electrodynamic condenser. E. E. F.

452. *The Time-relations of Oscillations in Condenser Circuits.* **M. Dieckmann.** (Ann. d. Physik, 24. 4. pp. 771–782, Dec. 17, 1907. Extract from

Inaug.-Dissertation, Strasburg.)—The author summarises his conclusions as follows: (1) The triple thermo-element zero method renders easy the determination of phase-differences of 90°. (2) It is, within certain limits, possible to obtain any desired phase-difference between two coupled circuits by simply varying the secondary spark-length. (3) The relation between the self-induction of the coupling circuit and the secondary spark-length has an influence on the constancy of the phase-difference of $\pi/2$. (4) The method would appear to be very suitable for investigation of the conditions of spark discharges. (5) The $\int_0^\infty i_1 i_2 dl$ curves render possible a sharper tuning of coupled circuits than can be attained by the Bjerknes method. (6) Capacities may easily be measured to within 0·1 per cent., and self-inductances and dielectric constants with a similar exactitude. The triple thermo-element circuit consists of three circuits having certain portions in common. The galvanometer circuit contains all three thermo-junctions in series, the middle junction being arranged to oppose the other two; all three junctions must be exactly similar. The right-hand circuit is coupled to one of the circuits under investigation, and contains the right and middle junctions only; the left-hand circuit is coupled to the other circuit investigated, and contains only the middle and left-hand junction. The e.m.f. on the galvanometer thus is proportional to—

$$\int_0^\infty (ai_1 + bi_2)^2 dl - \int_0^\infty (a^2 i_1^2 + b^2 i_2^2) dl,$$

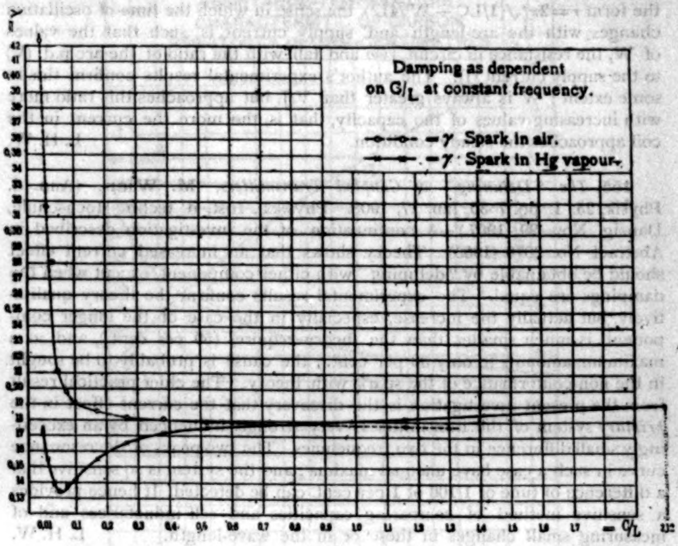
i.e., to—

$$\int_0^\infty i_1 i_2 dl,$$

where i_1, i_2 are the currents under investigation. When the value of this integral is zero the phase-difference is $\pi/2$. A research was made, in which phase-differences were obtained by Mandelstam and Papalexi's method [see Abstract No. 1277 (1906)]. By plotting the phase-differences as contour lines with the secondary spark-length and self-inductance of the coupling circuit as ordinate and abscissa, the experimental results are shown as a graded surface, which indicates very clearly the conditions under various circumstances. From the surface it is, for instance, easy to pick out the points where the variation of the phase with spark-length is slow, *i.e.*, the spark is stable. A comparison of an experimental curve, obtained by the method of the paper, with a Bjerknes resonance curve, shows the superiority of the former as a means of tuning coupled circuits. J. E.-M.

453. *The Mercury Vapour Lamp as Spark-gap.* **K. Markau.** (Deutsch. Phys. Gesell., Verh. 9. 23. pp. 700–714, Dec. 15, 1907. Physikal. Inst. d. Univ., Berlin, Nov., 1907.)—Referring to previous work on the mercury vapour spark-gap, the author points out that no definite information is obtainable therefrom as to the damping. The present experiments were for the purpose of determining in what way the decrement and spark-resistance in an oscillatory circuit containing a mercury vapour gap depend upon the temperature, capacity, and inductance. The damping was measured by Drude's method, with loose coupling. The mercury lamp being connected to the pump, change of pressure due to its heating was avoided by allowing the current to only flow for $\frac{2}{3}$ sec. six times for the complete resonance curve. The results show that for pressures 0·0285 to 0·0009 mm. the decrement varies from 0·127 to 0·070 and the resistance from 2·83 to 1·45 ohms (C = 402 cm.,

L = 2,557 cm., and λ = 64 m). As regards the effect of temperature, this is in all cases to reduce the strength of the oscillations. For temperatures from 18° to 100° at pressures 0·0009 to 0·0026 mm. the damping varies from 0·078 to 0·111 and the resistance from 1·58 to 2·45 ohms. Coming now to the effect of capacity (L being constant, 1,180 cm., and pressure 0·0005 mm.); to capacities ranging from 889 to 2,981 cm. correspond values of the damping ot 0·052 to 0·109 and resistances 0·76 to 0·48 ohms. The decrement thus increases with increase of C, the resistance, however, decreasing with such increase of C. The latter result is in agreement with Pierce's work [Abstract No. 1140 (1904)]. The influence of the ratio C/L is very remarkable. In the case of the spark in air, the damping is, as is well known, practically independent of this ratio. In the mercury vapour gap, on the other hand, this independence is only for values of C/L > 0·05. For smaller values of this ratio the damping *increases*. The resistance *decreases* rapidly with increase of C/L up to the value 0·05 for this ratio, after which it only very slightly decreases. The behaviour, in fact, is, as regards resistance, practically identical with that of the spark-gap in air. The Fig. shows very clearly the well-defined minimum of the damping and the divergence from the results for the spark-gap in air. The shape of the very pointed resonance curve is then discussed. L. H. W.



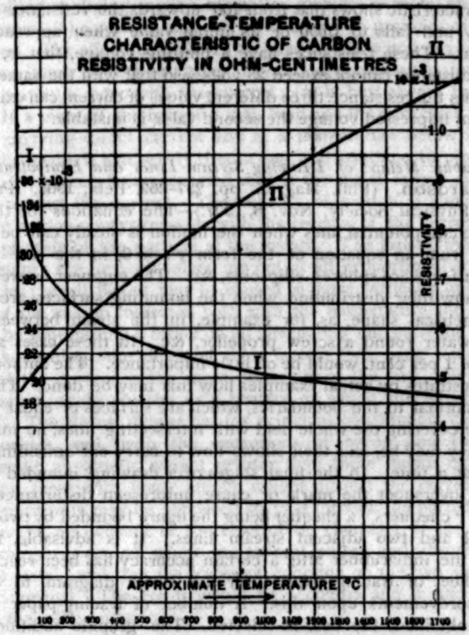
454. *Experiments with Undamped Oscillations.* **F. Kiebitz.** (Deutsch. Phys. Gesell., Verh. 9. 24. pp. 775–780, Dec. 30, 1907. Communication from the Kaiserl. Telegraphen-Versuchsamt.)—The first part of this article deals with the arrangement of the shunt circuit relatively to the arc. It is important that the leads should be arranged so as to be as nearly non-inductive as possible in order that there may be no magnetic coupling with the oscillatory circuit. The arc should be the only part common to both the supply circuit and the oscillatory circuit. When the self-inductance is very small the arc is very sensitive to changes in the supply p.d., and the wave-length varies considerably; the use of metal-filament steadying resistances (osram lamps) is recommended. When the inductance in the shunt circuit is sufficiently large, much less alteration in the wave-length is produced by changes in the supply p.d., and steadying resistances are not required. In the second part, the experiments carried out were to test Schalhorn's results [Dissertation, Rostock, 1906]: (1) That with the singing arc the values for inductance L as calculated from the capacity and time of oscillation by the usual formula are too large; (2) and that if the time of oscillation be represented by an expression of the form $\tau = 2\pi/\sqrt{(1/LC - W^2/4L^2)}$, the sense in which the time of oscillation changes with the arc-length and supply current is such that the values of W, the resistance in circuit, rise and fall with the ratio of the arc p.d. (V) to the supply current (J). The author's experimental results confirm this to some extent; W is always greater than V/J, but approaches this ratio more with increasing values of the capacity, that is, the more the current in the coil approaches the steady condition. L. H. W.

455. *The "Detuning" of Coupled Transmitters.* **M. Wien.** (Ann. d. Physik, 25. 1. pp. 7–30, Jan. 17, 1908. Physikal. Inst. d. techn. Hochschule, Danzig, Nov. 29, 1907.)—A continuation of the investigation described in Abstract No. 2076 (1906). Theory shows that an increased current effect should be obtainable by "detuning" with either component, except when the dampings are equal. The experimental results confirm the theory qualitatively, but actually the increase, especially in the case of the longer component, is much smaller than the theory requires (50 per cent.), and, as a maximum, amounts to only 30 per cent.; the cause is probably to be sought in the non-conformance of the spark with theory. The chief practical result from the present investigation is the discovery that the current effect in the *primary* system of the transmitter is very strongly influenced by an exceedingly small difference in the two frequencies. The two peaks of the resonance curve in such a case have unequal maxima; and the system is so sensitive that a difference of tune of 1/100 of 1 per cent. can be detected. It hence provides a sensitive method of comparing capacities and self-inductances and of measuring small changes in these or in the wave-length. L. H. W.

456. *Damping and Resistance in Condenser Sparks.* **A. Heydweiller.** (Ann. d. Physik, 25. 1. pp. 48–62, Jan. 17, 1908.)—The "spark characteristic" $v = a + b/i$ has been found to be a linear function of the spark-length. When the current is not very strong, the constants a and b are independent of the spark-length, and are the same as the constants of the glow discharge. The range of measurement is now extended to spark-gaps of 7 mm. The constant a becomes negligible when the resistance is high. In oscillating discharges through a low resistance, a is of considerable importance. The terms "resistance" and "apparent resistance" are used with some confusion in the case of sparks. The resistance can only be understood to mean the resistance of an equivalent solid conductor, and this may be variously determined by the heating effect of a current, from the damping of an oscillation, or from the relation between the current i and the p.d. v. These three methods fail to give consistent results in the case of sparks. It is, in fact, impossible to determine as in solids, the resistance of a spark from a single measurement, or even to define it by a simple relation. Spark-resistance must be defined by means of the two constants a and b. E. E. F.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

457. *Electric Conduction.* **C. P. Steinmetz.** (Amer. Electrochem. Soc., Trans. 11. pp. 81–113; Discussion, p. 113, 1907.)—A general *résumé* of the subject concluding with a new classification which shows that what have formerly been considered as different classes are merely types of conductors between which numerous intermediates exist. The author's scheme gives: 1) Metallic, (2) Electrolytic conductors, (3) Pyro-electrolytes (*i.e.*, substances which are insulators at ordinary temperatures but conduct at high temperatures), (4) Insulators, (5) Arcs, (6) Geissler discharges. Attention is called to the useful nature of the information given when the voltage consumed by the conductor as a function of the current is taken as the basis for plotting curves, in place of the more usual resistance-temperature characteristic; and typical curves of both types are given. Experiments are also described which serve to show the gradual transition from one type of conductor to the other. The resistance-temperature and the volt-ampere characteristics of carbon, cast silicon, and magnetite are shown in diagrams; the resistance-temperature diagram of pure carbon (maintained at arc temperature for considerable time) being of considerable interest in view of its applications in electric lighting, is here reproduced. Amorphous carbon (I) has a resistance at 20° C. of 34,000 microhms/cm.³ (see Fig.), and, as is well known, a negative temperature-coefficient. The curve (II.) for metallic carbon (*i.e.*, metallised)



shows that the resistance at 20° C. is only 480 microhms/cm.^{3}, or less than 5 times that of cast-iron, and the temperature-coefficient is positive (about 0·1 per cent. per 1° C.). In the case of silicon, the resistance is practically constant (185,000 ohms/cm.^{3} average) up to a dull red heat, and then slightly decreases, up to a bright red heat. Above this temperature it falls very rapidly, and afterwards more slowly. It therefore has the characteristic of metallic conduction at ordinary temperatures, changes to electrolytic conduction above red heat, and from thence upwards to the melting-point (probably 1,400° C.) has the characteristic of arc conduction. The magnetite resistance (a mixture of magnetite with chromite) is an example of the pyro-electrolytes. The volt-ampere characteristic shows that from 100° upwards the resistance decreases very rapidly and falls to 1/650 of its initial value when approaching the melting-point. These resistances have a limiting voltage, that is, the drop across the resistance cannot exceed 25 volts ; so that with the same terminal voltage across the resistance three different values of current can exist, though with constant impressed voltage the second value is unstable. L. H. W.

458. *Graphic Method of Drawing Stream Lines and Equipotential Lines.* **L. F. Richardson.** (Phil. Mag. 15. pp. 237–269, Feb., 1908. Paper read before the Physical Society, Nov. 8, 1907.)—The equations for the stream lines and the equipotential lines when the motion is steady can be obtained analytically from an equation of the form $\nabla^2\psi = 0$, in the case when the bounding surfaces are spheres, ellipsoids, &c. The engineer, however, often wants to know their distribution when the bounding surfaces are not of a simple geometrical shape, as, for example, in the steam between turbine blades, the water round a screw propeller, &c. In these cases a possible inaccuracy of 1 per cent. would be of little importance. The author explains fully, and illustrates by actual examples how this may be done. The stream lines being normal to the boundaries, which are surfaces of equal potential, he begins by covering the whole field with intersecting lines, no matter how erroneous they may be, and then shows how to carry out amendments over wide areas at a time. In the final stages of a drawing intended improvements often overshoot the mark or cause unforeseen disturbances in the surrounding "chequers," a chequer being the figure bounded by two adjacent equipotential and two adjacent stream lines. It is advisable, therefore, to lay aside the indiarubber after a certain accuracy has been reached, and, placing a sheet of tracing paper over the rough diagram, to draw the intended improvements upon this. A number of tracing-paper diagrams being thus obtained, the best is selected. The graphic addition of two scalar functions of position is conveniently performed in the way described by Maxwell in his "Elementary Treatise on Electricity," by laying the contours of the one down on a sheet of tracing paper at equal intervals over those of the other, covering the two with a clean sheet of tracing paper, and drawing the diagonals of the chequers formed by the intersecting contours. In conclusion, a method of estimating the probable error of a diagram is indicated. A. R.

459. *Movement of Particles on a Nernst Glower.* **C. E. Mendenhall** and **L. R. Ingersoll.** (Phil. Mag. 15. pp. 205–214, Feb., 1908. Electrician, 60. pp. 758–759, Feb. 28, 1908. Abstract.)—In the course of some work on the determination of high-temperature melting-points some curious movements of particles on a Nernst glower have been noticed, as well as some rather remarkable undercooling phenomena. If a small particle of platinum, about 1/20 mm. diam., is placed on the glower, melted, and then allowed to cool slowly or rapidly, it will not solidify at the melting-point, but will remain fluid until a temperature is reached which is 50° to 300° lower. Solidification then occurs suddenly, accompanied by a quick flash. Upon reheating there is no flash, and the drop melts at its proper melting temperature. Flashing appears to precede solidification; other metals beside Pt show the effect. It appears that the flashing is not a direct luminescent phenomenon, but is due to the sudden increase in temperature resulting from the liberation of the latent heat of fusion. The movements of the particles referred to above may be divided into two classes: (*a*) The rolling or sliding motion of molten globules of metal on the surface of the glower; (*b*) a curious end-over-end rolling of particles of metals and their oxides. The effect (*a*) is shown by most metals which can be melted on the glower; it may be with or against the current, according to the metal used. Gold and platinum move with the current; (*b*) is best shown by cobalt and copper. If a piece of the former 2 mm. long and 0·2 mm. thick is placed on a glower carrying direct current and at a temperature below the melting-point of the metal, it will slowly rise on end and continue turning over until it lies flat, the process being repeated so that the metal moves as a whole in this case against the current. The velocity of motion is about 1 cm. per min. The motion always reverses with the reversal of the current, no matter what the position of the particle at the instant. The size of the particles is not important; the forces involved are not at all proportional to the size of the particles; small pieces may be caused to move vertically upwards. The rapidity of the motion increases both with the temperature and the current-density; by superposing a direct on an alternating current—the latter doing most of the heating—the effects of these factors have been separated. It is found that the current is the more important of the two. Nernst glowers and zirconium oxide are the only heaters on which the effects have been produced. The Nernst glower has for principal constituents zirconium and yttrium oxides, and, with the exceptions of boron and ruthenium, all metals having an atomic weight greater than these metals move with the current and those with lower atomic weight against the current. Some of the glower current may be supposed to pass through the particle, and there would then be, on account of the electrolytic character of the glower conduction, oxygen given off where the current enters, and absorbed where it leaves the metal; and thus the forces of cohesion on the two sides would be rendered unequal. The result would be a couple, and it may be this that produces the rolling motion. R. S. W.

460. *Liquid Dielectrics.* **L. Malclès.** (Comptes Rendus, 145. pp. 1326–1327, Dec. 23, 1907.)—The author has previously shown that hard paraffin (melting at 72° C.) shows no residual dielectric effect [see Abstract No. 1057 (1907)]. The phenomenon of residual charge and discharge observed when solid dielectrics are placed between metal sheets is still noticed when the dielectric is immersed in paraffin and is not in contact with any metal surface. The author has extended his researches to liquid dielectrics. The liquid studied was poured into a cylindrical cavity in a paraffin disc placed between metal sheets forming a condenser and provided with a guard ring. The disc is slightly hollowed out on each side, contact with the metallic surfaces taking place only at the edges. A layer of air of thickness t exists between the plates of the condenser and the paraffin. Let S be the surface of the plane condenser, K the capacity per unit length of the cylindrical condenser, $+V$

the potential of the plane condenser, —V that of the cylindrical condenser, l the length of the cylindrical capacity equilibrating the plane condenser, t the thickness of the cylindrical cavity hollowed in the paraffin, and T the thickness of the paraffin walls. First experimenting with the paraffin disc not filled with liquid and then with it full of liquid we get—

$$l=(S/4\pi K)/(T/\lambda_1+t'+t)$$

and—

$$l=(S/4\pi K)/(T/\lambda_1+t'/\lambda_2+t),$$

where λ_1 and λ_2 are the dielectric coefficients of paraffin and the liquid under test respectively, corrections being made for residual charge. 2·28, 1·90, and 2·02 were obtained for the dielectric coefficients of benzine, vaseline oil, and turpentine respectively. He proves also that the distribution of potential in liquid conductors (water and mercury, for instance) is the same as that in dielectrics when the steady state is assumed. A. R.

461. *Comparison of Resistances.* **F. E. Smith.** (Electrician, 60. pp. 469–471, Jan. 10, and p. 566, Jan. 24, 1908.)—There is a correction to be applied to the formula given by Drysdale for the universal slide-wire bridge [see Abstract No. 2106 (1907)]. This is due to the resistance of the current or potential leads of the resistance coils not being measured and allowed for. When the bridge is arranged for maximum sensitiveness the error amounts to 1 part in 100,000 if the difference of resistance of the leads of the coils being compared amounts to 0·00001 ohm. When, however, the resistance of the ratio arms is increased the error is appreciably reduced.—**C. V. Drysdale** (ibid. pp. 471–472) shows how the measurement of the leads can be made on his bridge, but states that in practice he has preferred to use ratio resistances of high value. The probable error of a comparison is also increased owing to the comparatively high resistance which connects the two coils under observation, which resistance is shunted in the manner common to the Kelvin double bridge. If the resistance of the connecting-piece be 0·1 ohm, and resistances of nominal value 0·001 ohm are compared, the bridge sensitiveness is only 1 part in 10,000 if the galvanometer is sufficiently sensitive to detect a change in one of the ratio coils of 1 part in 1,000,000; the sensitiveness of the bridge increases, however, as the resistance of the connecting-piece is decreased. It appears that in the ordinary use of the bridge by Drysdale the value of the coupling resistance is probably less than 0·001 ohm, but if tests of the highest order of accuracy are to be made on coils of less than 0·01 ohm a modification of the coupling resistance is suggested. There is also described a bridge for the comparison of resistances as employed at the National Physical Laboratory [see Abstract No. 2079 (1906)]. F. E. S.

462. *The Self and Mutual Inductances of Linear Conductors.* **E. B. Rosa.** (Bureau of Standards, Bull. 4. pp. 301–344, Jan., 1908.)—Formulæ for the self and mutual inductances of straight wires and rectangles are to be found in various books and papers, but their demonstrations are usually omitted, and approximate formulæ are often given as though they were exact. The author derives the expressions very simply from Laplace's formula instead of using Neumann's formula, and thus gives a much better physical view of their meaning. He also deduces some interesting new formulæ. The assumption is made that the magnetic field has assumed its steady value, and the self-

inductance is taken to be equal to the energy stored in the magnetic field divided by half the square of the total current. For the mutual inductance M between two conductors of lengths l and m, end to end, in the same straight line we have—

$$M = l \log_e [(l + m)/l] + m \log_e [(l + m)/m]$$

very approximately. The formulæ for the self-inductance of a rectangular bar and of two parallel rectangular bars are also given. The self-inductance L of a rectangle of sides a and b, when the cross-section of the conductor is a circle of radius r is given by—

$$L = 4 [(a + b) \log_e (2ab/r) - a \log_e (a + d) - b \log_e (b + d) \\ - (7/4)(a + b) + 2(d + r)],$$

approximately, where $d = (a^2 + b^2)$, and if the conductor has a rectangular section, $h \times k$, we have—

$$L = 4 \left[(a + b) \log_e \left\{2ab/(h + k)\right\} - a \log_e (a + d) - b \log_e (b + d) \\ - (a + b)/2 + 2d + 0{\cdot}447 (h + k)\right].$$

The author gives a simple proof of Rayleigh's formula for the self-inductance of a short cylindrical current sheet, and also clear proofs of formulæ in connection with arithmetical mean distances. A neat formula for the self-inductance of multiple cylindrical conductors due to C. E. Guye is given, and a complete proof of G. A. Campbell's formula for the self-inductance of a "non-inductive" winding of round wires. A formula for the case of a non-inductive winding on a circular cylinder is also obtained. These formulæ will be useful to instrument makers. A. R.

463. *On the use of Variable Mutual Inductances.* **A. Campbell.** (Phil. Mag. 15. pp. 155–171, Jan., 1908. Paper read before the Physical Soc., Oct. 25, 1907. Electrician, 60. pp. 641–643, Feb. 7, 1908. Abstract. From the National Physical Laboratory. Lumière Électr. 1. pp. 343–346, March 14, 1908.)—Owing to many practical problems in wireless telegraphy, &c., the accurate measurement of small self-inductances and capacities has become of considerable importance. The author has found that suitably designed mutual inductances are of the greatest assistance in such measurements. The advantages of standard mutual inductances as compared with self-inductances are pointed out, and a description is given of the author's mutual inductance box. Various novel methods of measuring mutual and self-inductances and capacities by means of a vibration galvanometer are given. In an appendix a graphical method of calculating the mutual inductance of two parallel ring coils, the line joining the centres of which is not perpendicular to their planes, is described, and it is shown how it can be applied to calculating points on the scale of the author's apparatus. A. R.

464. *Inductance Measurements.* **A. Campbell.** (Electrician, 60. pp. 626–627, Feb. 7, 1908.)—This paper is supplementary to the author's Physical Society paper [see preceding Abstract]. A new method of measuring self-inductance is first described. Experimental results are quoted to show that the permeability of serpentine is variable. He has previously pointed out that Maxwell's method of comparing two mutual inductances is applicable to a single primary coil having two secondaries. A proof is given that this is not the case when two separate primary coils are used. For the measurement of capacity a variable mutual inductance standard furnishes a very convenient way of measuring the capacities of all values. Carey Foster's method is used, and the results quoted show the high accuracy that can be obtained. In conclusion, he shows how a standard of mutual inductance capable of very accurate adjustment can be made. A. R.

465. *The Self-inductance of Parallel Wires.* **J. W. Nicholson.** (Nature, 77. p. 295, Jan. 30, 1908.)—If we assume that the current density is uniform over the cross-section of two parallel cylindrical conductors, the self-inductance L is given by—

$$L/l = [4 \log_e (d/a) + \mu]\, 10^{-9} \text{ henrys},$$

where l is the length of the conductors in cm., μ the permeability of the conductor, d the distance between the axes of the conductors, and a the radius of either. In practice, however, the distribution of the current over the cross-section of the cylinders is modified by the mutual forces between the longitudinal filaments of current. The author gives the following as the complete solution for this case :—

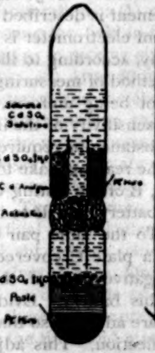
$$L/l = \Big[4 \log_e (d/a) + (4\mu/x)(\text{ber}\, x\, \text{ber}'\, x - \text{bei}\, x\, \text{bei}'\, x) \Big/ \big\{(\text{ber}'\, x)^2 + (\text{bei}'\, x)^2\big\}\Big]\, 10^{-9} \text{ henrys},$$

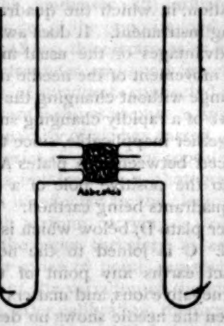
where $x = 2a\sqrt{\pi\mu\omega/\rho}$, $\omega = 2\pi f$, $\rho =$ the volume resistivity in c.g.s. units. Definitions of the *bei* and *ber* functions and tables of their values are given in Russell's "Alternating Currents," vol. i., p. 878. A. R.

466. *Thermoelectric Properties of Common Metals and their Alloys.* **A. G. Warren** and **F. Murphy.** (Electrician, 60. pp. 602–608, Jan. 31, 1908.)—In the experiments which were made, three cast phosphor bronze rods were soft-soldered together to form three sides of a square of 1 ft. side, and the material under test was soft-soldered to the free ends. The resistance r of the lengths of material, together with the rods, was then measured. The soldered junctions were inserted in two calorimeters containing water. For various temperatures T_1 of the hot junction, and T_2 of the cold junction, the current in micro-amps. a through a galvanometer of resistance R was measured. Then the thermo e.m.f. in microvolts is given by $e = (R + r)a$. Two diagrams are given for various values of $(T_1 - T_2)$. The authors found that different specimens of the same material yield sensibly different results. In the case of phosphor bronze the disparity which exists between the results given by the rolled rods and the other forms is especially remarkable. The results obtained, in an attempt to determine the magnitude of the error which might be produced at a silver-soldered junction, are also given for manganin and phosphor bronze. The effect produced on the latter was the more marked. **A. C. Jolley.** (Ibid. 681, Feb. 14, 1908.)—Jolley desires to know why Warren and Murphy used cast phosphor bronze with soldered joints as the base metal for comparison instead of copper bent to the required shape. In some experiments made by Jolley the galvanometer was calibrated as a microvoltmeter by shunting it with a suitable low resistance standard, through which a measured current was passed. This appears to have an advantage over the method used by Warren and Murphy. The writer also doubts if phosphor bronze would score over copper in potentiometer construction. **A. G. Warren** and **F. Murphy**, in reply (ibid. p. 681), suggest that lead is most commonly used as a base, but in their case for several reasons they regarded phosphor bronze as the most suitable metal to use. The soldered joints introduced no considerable error. With respect to the apparatus used it was easy to work with and sufficiently accurate. They cannot agree with Jolley as to the relative merits of phosphor bronze and copper for potentiometer construction, the thermo-e.m.f. per 1° C. between manganin and copper being greater than between manganin and phosphor bronze. F. E. S.

467. *Stability of Weston Cells.* **H. S. Carhart.** (Phys. Rev. 26. pp. 125–128, Jan., 1908. Electrician, 60. p. 848, March 13, 1908. Abstract.)—Evidence has recently been adduced by Hulett [see Abstract No. 1682 (1907)] tending to the conclusion that the chemical stability of the Weston or cadmium cell is inferior to that of the Clark; that its e.m.f. slowly declines to an extent that renders it less suitable for a primary standard than the Clark cell; and that this loss of e.m.f. is probably due to some secondary reaction at the surface of the mercury constituting the positive electrode. The author has studied a a series of cadmium cells set up nearly five years ago, and all save one are still in good order. One cell contained Merck's mercurous sulphate, and 9 others contained mercurous sulphate which had been precipitated with H_2SO_4 from a hot solution of $HgNO_3$. The author concludes that these cells have met every requirement of permanency. If the e.m.f. has fallen at all, then the e.m.f. of the Clark cells with which they were compared has also fallen. F. E. S.

468. *Transportable Form of Standard Cell.* **R. E. DeLury.** (Phys. Rev. 25. pp. 492–494, Dec., 1907. Electrician, 60. pp. 805–806, March 6, 1908.)—The ordinary or H-form of cell and also its modification the ⅄-form, possess the disadvantage that they are not transportable. In the cells illustrated, the contents cannot mix even though the cells be inverted or shaken. Some cells like the above were made during the past year at Princeton University, and transportation and rough treatment have not caused the contents of the two compartments of these cells to mix in the slightest degree. F. E. S.





469. *A Current Weigher and a Determination of the E.M.F. of the Weston Cadmium Cell.* **W. E. Ayrton, T. Mather,** and **F. E. Smith.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 463–544, Jan. 13, 1908. Proc., Ser.

A. 80. pp. 12–18, Dec. 9, 1907. Abstract. Electrician, 60. pp. 750–752, Feb. 28, 1908.)—A description is given of the current balance at the National Physical Laboratory and of the limits of the accuracy with which the geometrical data can be calculated. A steady current being passed through the balance and a standard resistance of 1 ohm (National Phys. Lab.), the e.m.f. (C × R) of the Weston cadmium cell was found to be $1{\cdot}01880_5$ volts at 17° C. As the value of g at Bushy is only known to within about 8 parts in 100,000, there is a possible inaccuracy in this value of 1·5 parts in 100,000. It is stated that the uncertainty in the absolute value of the international ohm is about 4 parts in 10,000. Assuming the value given above for the e.m.f. of the cadmium cell the e.m.f. of the Clark cell at 15° C. equals 1·432 volts. Full descriptions of the current weigher, of the tests, and of the calculations are given and the magnitudes of the possible errors in this important determination are discussed in full. In Appendix A the methods adopted by T. Mather for calculating the complete elliptic integrals when the modulus is nearly equal to unity are quoted, and a useful table has been appended. In Appendix B, G. F. C. Searle points out that Viriamu Jones's formula is only true when the windings of the coils can be considered as infinitely fine helical filaments. In default of an accurate knowledge of the variations of the volume resistivity over the cross-sections of the wires he works out the cases, (1) when the volume resistivity is uniform, and (2) when the current density at any point may be taken as inversely proportional to the length of one turn of the line of flow through that point. It is found that the corrections are of opposite sign in the two cases, and thus, as the distribution of current is uncertain, the simple formula given by Jones was adopted.
A. R.

470. *Null Instrument for Measuring Ionisation.* **S. J. Allen.** (Phil. Mag. 14. pp. 712–723, Dec., 1907.)—An arrangement is described for the measurement of ionisation, in which the quadrant electrometer is an indicating and not a measuring instrument. It does away, according to the author, with the following disadvantages of the usual method of measuring the rate of leak: (1) The rate of movement of the needle not being uniform, (2) it can be used over a wider range without changing the sensitivity of the instrument. (3) If the decay curve of a rapidly changing substance be required the rate-of-leak method is altogether inapplicable, since the readings take too long. Suppose ions are produced between two plates A, B of the testing vessel, of which A is connected to the positive pole of a battery, and B to the quadrants, the other pair of quadrants being earthed. To the same pair of quadrants as B is joined another plate D, below which is a plate C covered with a layer of active material. C is joined to the negative pole of the battery, and a movable contact earths any point of this battery. Evidently B receives positive and D negative ions, and matters are adjusted so that these just annul each other, when the needle shows no deflection. This adjustment is made by exposing a variable surface of C, a shutter being moved backwards and forwards and its position shown on a scale. In the instrument described the calibration of the part C D is made by the rate-of-leak method, although other means are suggested.
R. S. W.

471. *Electrometer for Registering the Ions in the Atmosphere.* **P. Langevin** and **Moulin.** (Le Radium, 4. pp. 218–229, June, 1907.)—In the course of experiments made during two years at the Eiffel Tower the authors have been led to the conclusion that in addition to the small ions similar to those produced, say, by Röntgen rays, there are present in the air large ions 1,000 to 3,000 times the size of the small ions, and of the order of magnitude one hundredth of a micron. The conductivity of the air is for the most part due to the small ions, for the large ions have a mobility much less than that of the small ions. The large ions are present in greater numbers when the atmosphere contains a greater number of particles in suspension. A large ion with a small one of the opposite sign goes to make up a neutral particle. The measurement of the charge on the large ions gives an easier method than that of Aiken for determining the degree of impurity of the atmosphere. The large ions and the neutral particles, of which they imply the presence, play an important part in the formation of the lower cloud layers (stratus and cumulus) between 1,000 and 2,000 m. high, the small ions having to do wit hthe higher clouds at a height of 10 to 12 km. The apparatus devised by the authors for estimating the number of either small ions or large ions in the atmosphere is a modification of Ebert's apparatus. A current of air (taken from the outside air by means of a special pipe) passes through a cylindrical condenser of which the internal armature communicates by means of an insulated wire with one pair of quadrants of an electrometer. The exterior armature is connected to one of the poles (*e.g.*, the positive) of a battery of small accumulators, whose other pole is joined to the electrometer case and to the other pair of quadrants. Under these conditions the interior armature, originally put in communication with the electrometer case, receives positive charges which cause a deflection of the electrometer proportional to the total charge received after the moment of insulation. The current of air is obtained by the aid of a gas-meter working in conjunction with an aspirator driven by a motor. After a certain number of turns of the meter an electric circuit is completed, so that the volume of the air can be exactly determined. The circuit, closed by this contact on the meter, actuates a small electromagnet which starts the following series of operations : (1) connects interior armature with case, at the same time reversing the field in the condenser ; (2) insulates the interior armature, which begins to receive charges of the opposite kind to what it has just been registering. (3) After 30 to 45 sec. the electrometer has reached its zero, which is registered, and the electrometer, up to now in contact with the case, is insulated from it and one pair of quadrants connected to the interior armature. The electrometer consequently shows at once a small deflection, which slowly increases till a certain quantity of air has passed, when contact is made by the meter and the whole series of operations repeated for ions of the opposite sign. The recording is obtained by a photographic method. The image of a vertical lamp filament is reflected by the electrometer mirror on to a horizontal slit behind which a drum carrying a strip of gelatine-bromide paper revolves slowly. On the paper, therefore, a series of inclined lines are obtained on each side of a series of points representing the zero. The extremities of these lines represent the variation of the ionisation of the air with respect to the time, and give, after calibration, the number of ions in unit volume. The enormous difference in the mobility of the large and small ions allows them to be easily separated ; a condenser of different capacity is required for each kind. For details of apparatus see original paper. A. W.

472. *Callendar and Griffiths' Self-testing Bridge.* (Electrician, 60. pp. 477–479, Jan. 10, 1908.)—An improved form of the bridge for platinum thermometer measurements, as made by the Cambridge Scientific Instrument Co. With a Pt thermometer of about 2·7 ohms it is capable of measuring temperatures on the platinum scale to 1/100th degree by direct reading on the

scale of the bridge wire. By taking as the unit of resistance, in the adjustable arm, 1/100th of the fundamental interval of the thermometer, the required temperature can be at once deduced on the platinum scale. The general arrangement of the box is shown by means of diagrams and a photograph. The adjustable resistances consist of nine coils of manganin wire of 5, 10, 20, 40, &c., units arranged on the binary system, and the resistance of the thermometer is adjusted so that the increase in resistance between 0° and 100° C. is exactly 1 ohm. Collins' patent mercury contacts are used in short-circuiting the coils of the adjustable arm when not in use, thus avoiding the trouble always present with plug contacts. In this form of contact a heavy plug depresses a spring, which forces a thick copper link into two mercury cups, the cups and their accessories being all enclosed in a separate compartment. The bridge wire is a thick one of platinum silver, and, to avoid temperature difficulties, the whole bridge system, including coils, bridge wire and slider, is immersed in oil which is kept in circulation by a fan. The slider carries a vernier, and the bridge can be used to measure small resistances not exceeding 25 ohms to 0·0001 ohm. The bridge is self-testing in the sense that the comparative value of the resistance coils can be tested at any time by means of the bridge itself, and their comparative errors determined.

G. E. A.

473. *Thermo-electric Couple Potentiometer.* (Electrician, 60. pp. 603–605, Jan. 31, 1908.)—This instrument, made by the Cambridge Scientific Instrument Co., is designed for measuring accurately small p.d.'s not exceeding 30 millivolts. The unknown p.d. is balanced by an adjustable p.d. standardised in millivolts by means of a cadmium cell. This adjustment can be made by direct reading to 1/100 millivolt, and by estimation of tenths to 1 microvolt.

F. E. S.

474. *Direct-reading Galvanometer Scale.* **J. Rymer-Jones.** (Elect. Rev. 62. pp. 44–45, Jan. 10, 1908.)—A description is given of a galvanometer scale, for use with a mirror galvanometer, from which the dielectric resistances of a number of condensers, or insulated wires, may be read off directly. Two scales are used, one above the other, the lower one divided into 1,000 equal divisions, while the upper, direct-reading scale is so graduated that its insulation values are in inverse proportion to the divisions on the lower scale. If therefore the testing galvanometer be shunted to make the testing battery give the full deflection through 1 megohm, and if this deflection is made to coincide with the 1-megohm graduation on the upper scale, then deflections of 500, 250, and 125 divisions should coincide respectively with 2, 4, and 8 megohms, and similarly with intermediate values. As the universal shunt is not always sufficiently subdivided to give exactly the full scale deflection of 1,000 divisions with the testing battery through 1 megohm, the multiplying power (*m.p.*) of the slide reading (*s.r.*) required to give 1,000 divisions is obtained by inverse proportion from the deflection (d) observed with a suitable slide reading having a multiplying power M.P.; *i.e.*, $m.p. = \text{M.P.} \times d/1000$, and its $s.r. = 10^7/(\text{M.P.} \times d)$. To avoid reading low down the scale, it is convenient to have (say) five different scales with different limits. By testing one of the set of condensers or wires with scale I., it will immediately be seen whether this, or one of the others, is best suited for the condensers or wires to be tested.

A. W.

ALTERNATING CURRENTS AND MAGNETISM.

475. *Use of Flames as a Rectifier for High-tension Alternating Currents.* **A. Cathiard.** (Comptes Rendus, 146. pp. 20–21, Jan. 6, and p. 229, Feb. 3, 1908.)—If two electrodes, one of which is very small with respect to the other, be placed in a flame (which should contain no solid conducting material in suspension) and connected to a high-tension source of alternating current, the current which passes will be unidirectional and flow from the large to the smaller electrode. The effect is increased if the small electrode consists of numerous fine points. Under these conditions a very slightly luminous arc is produced in the flame, the point at which the arc makes contact with the large ($+^{ve}$) electrode constantly shifting about. Flames with hydrogen, alcohol, illuminating gas, and especially the latter, burned in a Mecker burner with graphitic carbon electrodes, were tried. The small electrode was the cylindrical cross-section of a carbon ring 5 mm. diam. With voltages of 2,000 to 10,000 at 40 $\sim$, and a distance between electrodes of 5–10 mm., a mean current of 0·08 amp. was obtained. Above this value arcing took place and the effect was not obtainable. In the second article it is stated that an oscillographic examination of the effect shows that it is due to an actual disintegration of the kathode. If two identical electrodes are placed parallel in the same plane perpendicular to the flame, *whichever* electrode is pushed within the flame *becomes* the kathode; that which originally was, say, the anode becoming kathode on bringing the flame under it and away from the other electrode. L. H. W.

476. *Alternating-current Phenomena.* **L. Lyndon.** (Elect. Rev., N.Y. 52. pp. 60–61, Jan. 11, 1908.)—The author makes a plea for the physical treatment of alternating-current phenomena. The mathematician's obscuring standpoint is condemned. Mathematics only thickens the fog which physics easily clears. For instance, mathematically we have $A = V/(R^2 + L^2\omega^2)^{\frac{1}{2}}$, but $(R^2 + L^2\omega^2)$ is an erroneous combination, however useful it may be to the computer. The physical equation is $A = [V^2 - (L\omega A)^2]^{\frac{1}{2}}/R$, the meaning of which is at once obvious to the physicist. Of course, after a thorough understanding of the subject has been attained, the conventional mathematics may be employed to save labour in computing. A. R.

477. *Diamagnetism.* **R. Gans.** (Phys. Zeitschr. 9. pp. 10–13, Jan. 1, 1908. Physikal. Inst., Tübingen, Oct. 25, 1907.)—Points out the popular error according to which it is considered that paramagnetic bodies when free to move place themselves along the magnetic lines of force, and diamagnetic bodies across them. The reverse is the case in a divergent field in which the density of lines diminishes in opposite directions. This may be produced by the juxtaposition of two pairs of poles facing in opposite directions. A divergent field then exists midway between them, and a paramagnetic rod places itself across the lines, thereby embracing the largest possible number of them. E. E. F.

478. *Magnetic Behaviour of Air, Argon, and Helium.* **P. Tänzler.** (Ann. d. Physik, 24. 5. pp. 981–988, Dec. 31, 1907. Physikal. Inst., Halle, 1907.)—A comparison of the magnetic behaviour of the above gases with that of oxygen is made by means of a modification of Wiedemann's torsion method, the bulb containing the gas being carried on the end of an arm suspended horizontally, in the neighbourhood of the poles of an electromagnet, from a wire with a torsion head. By taking the value of $k \times 10^6$ (susceptibility reckoned for 1 cm.^{3}) for oxygen as 0·123 ± 0·004, the mean of values found by Henning, Du Bois, and Quincke, the results for the other gases are: air, +0·0264; argon, − 0·00958; and helium, − 0·00175. G. E. A.

479. *Specific Heat and Molecular Field of Ferromagnetic Substances.* **P. Weiss.** (Comptes Rendus, 145. pp. 1417–1419, Dec. 30, 1907.)—The decrease in intensity of magnetisation of ferromagnetic substances when heated, requires that energy should be furnished for the demagnetisation, in addition to the heat necessary for raising the temperature, thereby explaining the anomalous specific heats of these bodies. A magnetic term of the form $C^t_m = (1/2J)N \, . \, dI^2/dt$ must be added to the specific heat, J being the mechanical equivalent of heat, N a constant, and I the intensity of magnetisation. This term becomes zero at the temperature θ, where ferromagnetism disappears, and the following closely concordant results have been obtained by magnetic and calorimetric methods :—

	Magnetic.		Calorimetric.	
	θ	C^θ_m	θ	C^θ_m
Iron	753 + 273°	0·136	758 + 273°	0·112
Nickel	376 + 273°	0·025	376 + 273°	0·027
Magnetite	588 + 273°	0·048	580 + 273°	0·050

W. H. SI.

480. *Hysteresis in Rotating Fields.* **P. Weiss** and **V. Planer.** (Journ. de Physique, 6. pp. 5–27, Jan., 1908.)—An account of the author's determination of alternating and rotating hysteresis, so-called, by the mechanical method. The first part of the paper is occupied with a description of the two forms of apparatus, which are practically identical with the mechanical field construction of the Walter-Ewing detector [Abstract No. 857 (1904)]; the magnetic specimen is in the form of a thin disc, pivoted with its plane parallel to the axis of rotation of the field. The field strength was measured for various magnetising currents by means of Cotton's absolute electromagnetic balance, and the spring controlling the movement of the pivoted specimen was calibrated by measuring the times of swing of the specimen, alone and when loaded with a weight of known moment of inertia. The substances examined comprise pyrrhotine, nickel, soft iron, electrolytic iron, and steel. For normal pyrrhotine the ergs dissipated per cm.^{3} in rotating (E_t) and alternating (E_a) fields respectively range from 2,940 and 2,170 at H = 76 gauss up to 8,110 and 6,670 at H = 768; after which E_t declines steadily to 250 at H = 7,400, and then remain constant at this value up to H = 8,660. E_a, on the other hand, always increases with increasing H, up to 9,160 at H = 6,680. In abnormal specimens E_t decreases to zero at about H = 7,500. In the case of nickel, E_t almost disappears at H = 2,900. With less intense fields the ratio E_t/E_a varies from 2·79 at H = 24·8 to 1·38 at H = 97·3. With weaker fields the ratio reaches 3·62, at H = 9·7. The tables dealing with the results in the case of the iron and steel

specimens are here reproduced. The remarkably high value obtained for E_t/E_a with electrolytic iron in weak fields is worthy of note.

Soft Iron.					*Electrolytic Iron.*				
H. (gauss)	I c.g.s.	$E_t \frac{\text{ergs}}{\text{cm.}^3}$	$E_a \frac{\text{ergs}}{\text{cm.}^3}$	$\frac{E_t}{E_a}$	H. (gauss)	I c.g.s.	$E_t \frac{\text{ergs}}{\text{cm.}^3}$	$E_a \frac{\text{ergs}}{\text{cm.}^3}$	$\frac{E_t}{E_a}$
16·2	144	400	210	1·9	9·72	180	2,270	675	3·38
24·3	226	870	440	2·0	12·96	214	5,100	1,482	3·43
32·4	309	1,830	1,060	1·73	16·22	280	8,900	2,700	3·31
48·7	472	4,210	2,590	1·63	22·72	420	14,900	6,520	2·27
64·9	622	6,860	4,260	1·61	—	—	—	—	—
81·1	774	9,000	6,300	1·43	—	—	—	—	—
72·1	700	8,620	4,860	--	16·2	282	8,700	2,740	3·22
97·0	874	11,800	7,590	—	22·7	412	15,000	6,410	2·34
145·4	1,128	15,680	17,680	—	32·5	580	22,000	9,800	2·24
292·3	1,392	13,280	22,580	—	40·6	657	26,900	15,600	1·72
486·0	1,531	7,680	26,260	-	64·9	780	36,100	23,100	1·56
732·0	1,591	3,010	—	—	97·4	899	43,400	35,000	1·24
976·0	1,612	1,450	27,750	—	129·8	975	44,500	42,200	1·05
1,950	1,700	240	32,090	—	162·2	1,018	40,500	51,800	0·78
2,923	—	84	—	—	—	—	—	—	—
3,900	—	76	—	—	—	—	—	—	—

Steel.

H. (gauss)	I c.g.s.	$E_t \frac{\text{ergs}}{\text{cm.}^3}$	$E_a \frac{\text{ergs}}{\text{cm.}^3}$
16·2	40	80	40
24·3	63	270	100
32·5	85	610	210
40·6	108	1,350	470
48·7	132	2,760	890
64·9	182	6,830	2,140
97·3	288	20,440	6,890
129·8	398	44,090	15,290
162·2	462	—	27,080
72	201	8,640	—
97	286	20,890	—
145	460	55,880	—
195	649	89,670	—
244	880	114,670	—
390	1,140	105,860	—
486	1,280	81,820	—
782	1,850	45,710	—
976	1,885	28,900	—
1,464	1,420	14,490	—
1,950	1,452	8,510	—
2,920	1,580	3,310	—
3,900	1,610	1,130	—
4,880	—	280	—

L. H. W.

481. *Magnetic Induction in a Long Spheroid.* **D. N. Mallik.** (Phil. Mag. 15. pp. 65–68, Jan., 1908.)—In a paper on magnetic induction in a spheroid due to a coil carrying a current [Abstract No. 1981 (1907)], it was proved that $B=\int M dS=(1+4\pi k)2\pi mi\left(1-\frac{4}{8\pi}\right)\int dx$, nearly where dS is an element of surface, and dx an element of the major axis. This makes dB/dx constant. In this form it is suitable for experimental verification, and the author made a series of experiments to test its accuracy. An approximately spheroidal rod of very mild Bessemer steel was well annealed, and a coil was wound round half its length. A current being passed through the coil, the rod was magnetised, and the magnetic induction was explored over the projecting portion of the rod. The theory was confirmed. The formula is also true for a cylindrical rod with rounded ends if the rod is thin enough. In that case, also, the lines of force are radial and uniformerly distributed. The linear density of induced magnetism in a long thin cylinder due to a coil embracing half its length is constant. This relation may be used to find the variation of k with the current. Up to about 0·8 amp. k is constant.

E. E. F.

REFERENCES.

482. *On Maxwell's Theory of Action at a Distance.* **C. Somigliana.** (Accad. Lincei, Atti, 16. pp. 719–729, Dec. 1, 1907.)—A mathematical consideration.

483. *Rolling of Thunder.* **D. S. Carpenter.** (Electrical World, 50. pp. 1211–1213, Dec. 21, 1907, and 51. p. 306, Feb. 8, 1908.)—Endeavours to account for the rolling sound heard from thunder by secondary discharges due to the release of the charges when the first flash occurs. **B. F. Groat.** (Ibid. 51. p. 103, Jan. 11, 1908.)

E. H. B.

484. *Positive Rays.* **H. Konen.** (Deutsch. Phys. Gesell., Verh. 9. 24. p. 774, Dec. 30, 1907.)—Comes to the same conclusions with respect to Lilienfeld's positive rays [see Abstract No. 109 (1908)] as Gehrcke and Reichenheim, and Goldstein [Abstract No. 110 (1907)]. [See also Abstract No. 441 (1908).] R. S. W.

485. *Sliding Sparks.* **M. Toepler.** (Phys. Zeitschr. 8. pp. 919–923, Dec. 15, 1907.)—An addendum to the author's previous work [Abstract No. 2090 (1907)].

486. *Increasing the Output of Röntgen-ray Tubes by Application of a Magnetic Field.* **J. Trowbridge.** (Amer. Journ. Sci. 25. pp. 143–144, Feb., 1908.)—An account of the experimental arrangement which gives the best results with a longitudinal magnetic field as described in Abstract No. 1102 (1906). L. H. W.

487. *Undamped Electrical Oscillations.* **H. T. Simon.** (Jahrbuch d. Drahtlosen Telegraphie, 1. No. 1. pp. 16–68, Oct., 1907. Inst. f. angew. Elektrizität, Göttingen, July, 1907.)—A lengthy discussion, both theoretical and experimental, of the conditions associated with the singing arc and with the production of electrica oscillations by the arc method. The chief conclusions as to the effect of Poulsen's improvements have been briefly set forth elsewhere [Abstract No. 194B (1908)].

L. H. W.

488. *Regulation of Resonance Transformers.* **A. Blondel.** (Soc. Franç. Phys., Bull. No. 3. pp. 233–263, 1907. Journ. de Physique, 7. pp. 89–118, Feb., 1908.)—[See Abstract No. 839B (1907).] A. R.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

489. *Atomic Weight of Radium.* **H. Wilde.** (Manchester Lit. and Phil. Soc., Mem. 52. 1. pp. 1–3, Jan. 28, 1908. Phil. Mag. 15. pp. 280–282, Feb., 1908.)—The combining equivalent of radium chloride with Ag, determined by the method of Marignac and Dumas, is 1·176 : 1, whence the combining weight of radium with chlorine is 92, or exactly one-half the atomic weight of 184 already assigned to the element by the author from considerations of periodicity [see Abstract 560 (1907)]. W. H. Si.

490. *Evolution and Devolution of the Elements.* **A. C. Jessup** and **A. E. Jessup.** (Phil. Mag. 15. pp. 21–55, Jan., 1908.)—Recent researches have brought to light the fact that some of the elements are disintegrating into simpler forms of matter. But we have as yet no indications that elements with low atomic weight are changing into other elements with a higher atomic weight, that is, there is apparently no inorganic evolution. But a certain evolution is suggested by astrophysical observations. Spectroscopic evidence shows that the nebulæ contain but few elements, all of which are in a highly attenuated form. The only two which have been recognised on the earth are hydrogen and helium, and the atomic weights of these are less than those of any other elements. The evolution of the elements may be regarded as taking place in two ways. Firstly, the elements may evolve in order of atomic weight—*i.e.*, along horizontal lines of Mendeléeff's table. Secondly, they may evolve in groups—*i.e.*, down its vertical columns. The authors give reasons for believing that the second method has most in its favour. In the first place, the elements which appear after hydrogen and He are C, Si, Mg, Ca, and Fe, but these are in no way in order of their atomic weights. Moreover, sodium, although much smaller quantities of it can be detected, and with a much lower atomic weight than Ca or Fe, does not appear until long after these elements. The first positive evidence of sodium is in the case of the stars of group 7. Secondly, the whole of the nitrogen group is missing in the sun. On the supposition that the elements grow in groups, the fact that nitrogen did not form in the sun would account for the absence of the other members of its family. The other method of growth would imply that each of the five elements belonging to the group was missed out in the ordinary process. The nebulous stage of matter is the first of which we have any knowledge. The spectra of the very earliest nebulæ consist of three lines only. Their wave-lengths are 5,007, 4,959, and 4,862 Å.U., and they correspond to hydrogen and two unknown elements. As a nebula grows more compact two more lines appear with wave-lengths 4,340 and 5,876. These are due to hydrogen and helium respectively. Consequently we may suppose that in the nebulous stage of matter there are four substances, the first two being unknown upon earth, the third being hydrogen, and the fourth, which apparently exists only in small quantities, being helium. It also seems probable that except these four no other elements exist in the early nebulæ, and if this is the case we are justified in assuming that hydrogen, the two unknown elements and helium are the four original elements from which all the other elements are derived. To distinguish them from the others, the authors term them protons. The authors deal as follows with the problem of disintegration of radium : "It is not unreasonable to suppose that if in the process of evolution an unstable element were produced, it would break down and give off one or more of these nuclei. This nucleus would have a mass equal to that of the original antecedent element. It is these nuclei which determine the particles. We believe that the atomic weights of proto-beryllium and of proto-boron lie between 1 and 4, and this does not differ from the results so far obtained for the mass of the particles. If it be granted that an α-particle is a proton, we can trace the change through which an atom formed according to our theory would go. For example, let us consider the case of radium. The atom is approximately 224 times the weight of a hydrogen atom, and has been evolved from an element having an atomic weight not far from 1·8. That is to say, the outer ring of the element radium could be looked upon as being composed of nuclei, each nucleus being, by our principle of 'heredity,' of the same type and shape as that of the original element, proto-beryllium. Now this element radium is unstable. It proceeds to lose one of its nuclei. The whole of the remaining atom will then seek to find the next position of stability. It might take the position of the last element in group 1, but this would be no more stable than its original position ; and so it seeks to establish itself in group 8, forming the emanation. When the particle, which we believe becomes an atom of proto-beryllium, leaves the atom of radium, the outer ring of radium is left with groups of eight electrons. That is to say, in so far as its outer ring only is concerned, the emanation belongs to the helium family. Now this emanation again proves to be an unstable atom, possibly owing to the fact that its outer ring is of quite a different type to the inner ones. It again breaks down, giving up more α-particles. Now inasmuch as the outer ring of the emanation is of the helium type, so the particles are helium atoms." E. E. F.

491. *Specific Gravity and Allotropic States of Sulphur. Determination of Specific Gravity of Powders.* **W. Spring.** (Soc. Chim. de Belgique, Bull. 21. pp. 248–257, 1907. Rec. Trav. chim. 26. p. 357, 1907. Abstract. Journ. Chim. Phys. 5. p. 410, 1907.)—By decomposing potassium polysulphide with HCl white amorphous sulphur is obtained, completely soluble in CS_2, and having the density 2·0545 at 15° C. in fine powder, and of 2·0511 at 10° C. when compressed into cylinders. It has a lower thermal capacity than rhombic sulphur, into which it rapidly passes on heating, and more slowly at ordinary temperatures. This variety forms 96·8 per cent. of the sulphur precipitated by passing H_2S into a solution of $FeCl_3$, the remainder consisting of another amorphous modification, which is insoluble in CS_2, has the density 1·8686 at 16° C. in powder, and 1·7852 at 18° C. when compressed into cylinders. In neither case is any sulphur hydrate apparently produced. The specific gravities of the powders has been determined by mixing with H_2O in platinum vessels, and exposing under reduced pressure until the powders appeared to have completely settled, the weight continuing to increase for several days owing to incomplete sedimentation. The rate of this increase is at first irregular, but afterwards becomes proportional at any instant to the mass of powder still in suspension. W. H. Si.

492. *Auto-reduction of Metallic Oxides in the Kathode-light Vacuum, and Volatility of the Corresponding Sulphides.* **F. Damm** and **F. Krafft.** (Ber. Deut. Chem. Gesell. 40. pp. 4775–4778, 1907. Chem. News, 97. p. 48, Jan. 24, 1908. Abstract.)—The oxides of Pb, Bi, and Sb are reduced to the metals when heated in a vacuum to temperatures of 750°, 650°, and 1,050° respectively. The sulphides of these metals are more stable on heating, and can be separated almost quantitatively by distillation in the vacuum of the kathode light. Thus, PbS volatilises at 600°, Bi_2S_3 at 740°, and Sb_2S_3 at 580°, while CdS sublimes at 770–780°, and As_2S_3 at 230° Mixtures of S, Se, and Te can also be separated in this way. W. H. Si.

493. *Electric Furnace Reactions under High Pressure.* **R. S. Hutton** and **J. E. Petavel.** (Roy. Soc., Phil. Trans. Ser. A. 207. pp. 421–462, Jan. 17, 1908. Proc., Ser. A. 79. pp. 155–157, April 24, 1907. Abstract. Engineering, 85. pp. 259–262, Feb. 21, and pp. 289–293, Feb, 28, 1908.)—A large and a small type of furnace used for the experiments are described. These consist of strong outer casings of steel. The smaller furnace was used for high tensions, up to 25,000 volts, and pressures up to 200 atmos. were employed. A concentrated and compressed atmosphere of CO has little effect upon the formation of calcium carbide. The total power consumption, between 5 and 20 kw.-hours, does not affect the efficiency of this process. At pressures of 50 to 100 atmos. it was found possible to form thick-walled hollow cylinders of silica 25 cm. long and 15 to 20 cm. external diam. round a central carbon resistor, but the product was not more free from minute gas-bubbles than if made at atmospheric pressure. Under a pressure of hydrogen the result was no better, and the silica broke with almost explosive violence. An attempt to improve the product by maintaining the highest possible temperature also gave a negative result. Under high pressures the production of carborundum becomes very difficult, which confirms the view that carborundum is formed by the interaction of silica vapour with highly heated carbon. Attempts to reduce alumina by carbon showed that in the resistance furnace neither Al nor its carbide is produced, and that, on the other hand, all arc furnaces give a more or less marked reduction, the product being chiefly carbide. Alumina apparently is reduced at a minimum temperature coinciding with its melting-point. The presence of another metal—*e.g.*, Cu—was adopted as a means of absorbing any volatilised Al when signs of free Al were observed. The evidence appears to show that if aluminium carbide be formed the other metal will decompose it, alloying with the Al. The suggestions for future better yield are the application of high pressure for reducing vapourisation of the metal, the rapid removal of the CO or its dilution by an inert or reducing gas, and a modification of the apparatus to facilitate the condensation, and to prevent the metal from flowing into a bed of very hot carbon. F. R.

494. *Use of Lumière Colour Photography in Metallography.* **P. Goerens.** (Metallurgie, 5. pp. 19–23, Jan. 8, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—The importance in some cases of the differentiation of constituents of metallographic preparations by means of colour effects obtained by heat tinting or other chemical means, rather than by means of relief effects, is emphasised. Two reproductions of plates by the Lumière process are given. These represent iron containing carbon, 0·04 ; Mn, 0·3 ; and P, 1·5 per cent., which was treated with a very dilute solution of picric acid in alcohol and afterwards heat tinted. The Lumière process is outlined. For metallographic work the ordinary optical arrangement answers, with the addition of a suitable yellow screen at the principal iris on the bench. The examples given were taken with the arc lamp, but it is expected that the limelight will give better results as the light is more purely white. F. R.

495. *Heat Treatment of Copper-Zinc Alloys.* I. *Muntz Metal.* **G. D. Bengough** and **O. F. Hudson.** (Soc. Chem. Ind., Journ. 27. pp. 43–52; Discussion, p. 52, Jan. 31, 1908. Paper read before the Liverpool Section.)—The Muntz metal experimented upon was partially hot rolled, and finished by cold rolling. The tensile strength was then about 30 tons per sq. in. Annealing for 7 hours had the effect of reducing the strength. After annealing at 600° C., the strength was about 23·5 tons per sq. in.; this was not considerably reduced by annealing at higher temperatures. The elongation was increased by annealing for 7 hours at temperatures up to 550°, from 37 to 57 per cent. on 2 in.; with still higher temperatures the elongation fell away. Annealings for ½ hour gave a gradual reduction of tensile strength with higher annealing temperature, and a max. of 54 per cent. elongation after annealing at about 760°. The authors' views on the constitution of the copper-zinc alloys have previously been dealt with [see Abstract No. 1476 (1906)] and confirm in part those of Shepherd [Abstract No. 2774 (1904)]. These are still further supported by the study of the microstructure in the present paper. In particular the brittleness of the β constituent is emphasised. The retention of a considerable proportion of β as such upon quenching alloys of about this composition (60 Cu, 40 Zn, per cent.) explains why their brittleness is greater than when slowly cooled; *e.g.*, after heating for 7 hours at 590° a bar cooled slowly had 23·8 tons per sq. in. strength and 52·5 per cent. elongation; quenched the strength was 26·4 tons, elongation 45·7 per cent. F. R.

496. *Acid-resisting Alloys.* **A. Jouve.** (Soc. Ing. Civ., France, Mém. 60. pp. 641–648, Dec., 1907. Houille Blanche, 6. p. 285, with Discussion, Dec., 1907.)—The alloys used in the chemical industries, which are unattacked by acids in the hot or cold state (métillures), are the ferro-silicons with high silicon content. These are cast, their physical properties being similar to those of white iron. Some sulphuric and nitric acid pans made of ferro-silicon, put to work in 1903, are still in use. In reply to **L. Guillet**, the author stated that the most satisfactory compositions are near to the compounds Fe_2Si, FeSi, $FeSi_2$. The compounds themselves are the most resistant chemically but are extremely brittle. It is probable that ferro-silicon alloys will be found suitable for ozone apparatus. As regards the decrease of the brittleness of the alloys with lapse of time, Guillet referred to parallel cases of spontaneous annealing of alloys. F. R.

497. *Effects of Work and Heat Treatment on Structure of Metals.* **W. Campbell.** (Metallurgie, 4. pp. 801–809, Dec. 8, and pp. 825–834, Dec. 22, 1907. From the Metallograph. Inst. of Columbia Univ., New York.)—A continuation of the work referred to in Abstracts Nos. 1794B and 2789B (1904). Notes on the structures of Au, Ni, and Pt are given in addition to the metals dealt with in the papers referred to. The results are mostly confirmatory of accepted views. In naturally occurring and electrolytically precipitated metals there is often a tendency to twin crystallisation, and also to imperfections of growth due to interference. F. R.

498. *Alloys of Copper with Cobalt, Iron, Manganese, and Magnesium.* **R. Sahmen.** (Zeitschr. Anorg. Chem. 57. 1. pp. 1–33, Jan. 25, 1908. Metallograph. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Describes the study of these alloys by thermal methods, the results being

substantiated by microscopic examination. The points of magnetic transformation of the first two pairs are also determined. All four pairs are miscible in all proportions in the molten condition. The Co-Cu alloys form two sets of mixed crystals, containing up to 10 per cent. Cu at one end, and up to 4·5 per cent. Co at the other end of the series. The alloys containing, between 10 and 95·5 per cent. Cu consist of a mixture of these mixed crystals. The temperature of magnetic change varies from 1,085° for the 5 per cent. Cu alloy, to 880° for the 98 per cent. Cu alloy on heating; the corresponding cooling figures being 1,090° and 850°. The Fe-Cu alloys also form two sets of mixed crystals, containing up to 3·5 per cent. of Cu in iron at one end and up to 2·75 per cent. Fe in copper at the other end. The alloys containing between 3·5 per cent. and 97·25 per cent. Cu consist of a mixture of these mixed crystals. The temperature of magnetic change in these alloys occurs at about 800° on heating and 790° on cooling. The Mn-Cu alloys form a continuous series of mixed crystals with a minimum melting-point of 866° at about 65 per cent. Cu. The Mg-Cu alloys form two compounds, Cu_2Mg with a melting-point 797°, and $CuMg_2$ with a melting-point of 570°. These divide the series into three eutectiferous portions, the first consisting of Cu or Cu_2Mg, in a eutectic of these two, this eutectic point occurring with 9·5 per cent. Mg, and having a melting-point 730°; the second portion consists of Cu_2Mg or $CuMg_2$ in a eutectic of these two, this eutectic point occurring with 33 per cent. Mg and having a melting-point 555°; the third portion consists of $CuMg_2$ or Mg in a eutectic of these two, the eutectic point occurring with 68 per cent. Mg and having a melting-point of 485°. C. O. B.

499. *Cast Iron as Cast and Heat Treated.* **W. H. Hatfield.** (Iron and Steel Inst., Journ. 74. pp. 79–98, 1907. Carnegie Research Report.)—From experiments in which a cast iron (carbon 3·4, Si 1·1 per cent.) was slowly cooled to various temperatures and then quickly cooled, it is concluded that Fe_3C is decomposed between 900° and 800° C., and "$Fe_{24}C$" between 740° and 650°. Annealing carbon is thought to be quite amorphous. The tensile strength of cast iron was not so great when poured at a "fair" temperature as when poured "hot" or "cold." These differences disappeared upon thoroughly annealing the samples. [See also Abstract No. 184 (1907.)] F. R.

500. *Non-metallic Impurities in Steel.* **E. F. Law.** (Iron and Steel Inst., Journ. 74. pp. 94–105, 1907. Carnegie Research Report.)—Iron sulphide rarely occurs in commercial steels. Manganese sulphide always occurs, and is usually harmless, except when it segregates with phosphide of iron to form "ghosts." Manganese and iron silicates often occur and are highly injurious; they can ordinarily only be indicated under the microscope. Iron oxide is frequently found in Bessemer steel; methods for determination of oxygen are given. Experiments show that iron oxide is reduced at 100° C. by hydrogen. The presence of iron oxide accelerates corrosion electrochemically. [See also Abstract No. 186 (1907).] F. R.

501. *Case-hardening.* **G. S. Scott.** (Iron and Steel Inst., Journ. 75. pp. 120–136, 1907. Mech. Eng. 20. pp. 452–454, Sept. 28, 1907. Abstract. Metallurgie, 4. pp. 715–720, Nov. 8, 1907.)—Contains experimental results on the influence of temperature, time, and different cementing materials on the process of case-hardening. No carbon penetration is found on heating mild steel bars in burnt leather for 4 hours at 700°; a penetration to 0·13 mm.

is found after similar treatment at 800°, whilst at 900° the penetration of carbon reaches 1·58 mm. At 1,000° the penetration is found to be more than twice that obtained at 900° for equal times, but becomes irregular, and free cementite is found near the outside—a condition of things generally regarded as unsatisfactory in case-hardened goods. It is found that a mixture of barium carbonate and wood charcoal gives the most rapid penetration for a short time, burnt leather coming next, whilst wood charcoal gives the least. When the heating is sufficiently prolonged, however, the several mixtures give approximately the same results. With anthracite and hard coke (substances practically free from nitrogen) very slight carbon penetration is obtained, and results are given showing the effect of passing ammonia through the box during the heating, which is to slightly increase the depth of penetration. Heating mild steel to 550° in an atmosphere of ammonia causes "twinning," and it is suggested that this is an indication of the change of the iron from the α to the γ state, in which latter state the iron combines more readily with carbon. C. O. B.

502. *Hardened Steels.* **P. Longmuir.** (Iron and Steel Inst., Journ. 75. pp. 137–143, 1907. Mech. Eng. 20. pp. 471–474, Oct. 5, 1907. Metallurgie, 14. pp. 742–745, Nov. 8, 1907.)—Contains examples of the various structures obtained on hardening steels under different conditions, and states that in hardening practice the following points are important: (1) Care should be taken to have present the exact amount of carbon experience has indicated as being desirable; the usual range being from 0·5 per cent. to 1·5 per cent. (2) Only in exceptional cases are cast materials submitted to hardening. (3) Whilst heating temperatures may reach 1,000°, quenching temperatures never attain this point, the usual practice being to quench at as low a temperature as is consistent with the properties desired in the tool. (4) Quenching baths when of plain water are usually aired, but never fall below atmospheric temperature. (5) After water-hardening the majority of tools are tempered. C. O. B.

503. *Ageing of Mild Steel.* **C. E. Stromeyer.** (Iron and Steel Inst., Journ. 75. pp. 86–107; Discussion, pp. 108–113, 1907. Engineering, 84. pp. 823–826, Dec. 13, 1907. Metallurgie, 4. pp. 748–759, Nov. 8, 1907.)—Further test results of the kind referred to in Abstract No. 1947 (1907) are given. It is concluded that bending tests of samples with sheared or planed edges are not discriminative, the best test being the bending of samples with planed and nicked edges, so far as the study of ageing is concerned. It is considered established that mild steels possess ageing properties, but the experiments have not revealed a test capable of differentiating between reliable and treacherous qualities of steel. The following elongations were obtained as averages from a series of steels, calculated from the curvature at the edges of the bending specimen: Tested immediately after notching, 24; tested 17 weeks after notching, kept at atmospheric temperature, 12; 15 min. after notching, kept in boiling water, 8; 17 weeks after notching, kept in steam at 120 lbs. pressure, 8; 17 weeks after notching, kept at —16° F., 16. There is some evidence for the view that where a permanent tensile or shear stress exists in the metal ageing occurs, but where a permanent compression occurs there is no ageing. Results of hardness (Brinell) and tensile impact tests (Hatt) [see Abstract No. 2797B (1904)], and photomicrographs are given. F. R.

504. *Constitution of Manganese Cast Iron.* **L. Guillet.** (Comptes Rendus, 146. pp. 74–75, Jan. 13, 1908.)—The author now admits an error in his early conclusions regarding the constitution of cast irons containing Mn [see Abstract No. 166 (1908)]. With high Mn contents the eutectic formerly taken to be that of ferrite-cementite (*i.e.*, pearlite) is now shown to be that of mixed crystals—cementite. The higher the Mn content the greater the proportion of carbide. The alloy containing 3·6 per cent. carbon and 15 per cent. Mn slowly cooled consisted almost purely of eutectic. In certain cases γ-iron and carbide exist in the same specimen without any eutectic being present. γ-Iron appears upon addition of Mn to a grey iron before the complete disappearance of graphite. F. R.

505. *Solubility of Graphite in Iron.* **C. Benedicks.** (Metallurgie, 5. pp. 41–45, Jan. 22, 1908. Chem. Universitätslaborat., Upsala, Dec., 1907.)—An iron consisting entirely of ferrite and graphite was obtained by repeatedly heating a sample of grey iron (carbon 3·9, Si 0·75, and Mn 0·37 per cent.) to 800° C. and cooling slowly. Much of the carbon was thus in the form of temper carbon. Upon heating for one or two hours at about 940° the specks of temper carbon disappeared and were replaced by granular pearlite. With slow cooling there were considerable areas of granular pearlite. Upon quenching in oil after the annealing at 940° more or less of the hardening constituents were obtained. The conclusion is a confirmation of the view that at this temperature the solubility of graphite in iron is considerable. The author favours the view that for the stable system : ferrite + graphite, the equilibrium diagram should contain a curve falling from 1,130° at 2 per cent. carbon to 800° at 0·7 per cent. carbon, with an error of about ± 0·2 per cent. carbon. Further quantitative work is considered desirable. F. R.

506. *Decarbonising Cementation.* **F. Wüst.** (Metallurgie, 5. pp. 7–12, Jan. 8, 1908. Communication from the Eisenhüttenmänn. Inst. d. Kgl. techn. Hochschule, Aachen.)—Discusses the theories of the changes which take place during the manufacture of malleable iron castings, and gives experimental evidence, illustrated with photomicrographs, of a new theory. Shows that the process takes place in two distinct stages: Firstly, the decomposition of cementite into temper carbon and pure iron; and secondly, the gasification and removal of this temper carbon. It is shown that decarburisation takes place not only where the iron is in contact with the oxidising agent, but also throughout the whole piece of iron. When white iron is heated for 2 hours at 950° *in vacuo*, 71 per cent. of the carbon is converted into temper carbon and there is no loss noted. During the decarburising experiments, commenced *in vacuo* in porcelain tubes, the gases formed are drawn off and analysed for CO and CO_2, and the variations in pressure during the experiments are noted. The conclusions drawn from the results of the experiments are, that the decarburisation is commenced by oxygen from the ferric oxide—either in contact or separated from the white iron—combining with the temper carbon to form CO_2. This CO_2 penetrates the iron, combining with a further quantity of temper carbon, and forming CO. The CO_2 is regenerated from this CO by a reaction with the ferric oxide, this latter being reduced. When insufficient ore oxgyen is present the proportion of CO rises in the gas mixture to such an extent that decomposition takes place, the iron is recarburised, and CO_2 is formed. C. O. B.

507. *Organic Solvent for certain varieties of Carbon.* **I. Ostromysslensky.** (Journ. Prakt. Chemie, 76. 2. pp. 268–278, 1907.)—Amongst the high molecular polycyclic hydrocarbons it is found that decacyclene at 485° is capable of dissolving or at least disintegrating graphite. The operation must be conducted in an atmosphere of CO_2 in order to avoid decomposition of the decacyclene. The colour of the decacyclene becomes changed from brownish-black to black. Decacyclene does not dissolve diamond, and phenanthrene, chrysene, pyrene, picene, and triphenylene do not dissolve graphite. F. R.

508. *Density, Electrical Conductivity, and Viscosity of Fused Salts.* **H. M. Goodwin** and **R. D. Mailey.** (Amer. Electrochem. Soc., Trans. 11. pp. 211–228, 1907. Phys. Rev. 25. pp. 469–489, Dec., 1907, and 26. pp. 28–60, Jan., 1908. Contribution from the Research Laboratory of Physical Chemistry, No. 16.)—Curves are given showing the change of density with the temperature of sodium, potassium, lithium, and silver nitrates and silver chlorate, and of mixtures of sodium and potassium nitrates, and of lithium nitrate and silver chlorate. In all cases the density is a linear function of the temperature over the range of the latter investigated to within 0·1 per cent. The specific volumes of mixtures of sodium and potassium nitrates containing 8 and 2, 5 and 5, and 2 and 8 mols. of these salts respectively, is greater than those calculated from the specific volumes of the components, the expansion reaching a maximum value of 0·5 per cent. for the equimolecular mixture. With a mixture of lithium nitrate (1 mol.) and silver chlorate (1 mol.), a contraction of about 20 per cent. occurs. The specific conductivities of these salts and mixtures of salts increases less and less rapidly as the temperature rises, except with lithium nitrate and silver chlorate and a mixture of the two, which were only examined over a small range of temperature owing to their instability. The equivalent conductivity increases very nearly linearly with temperature. The equivalent conductivity of mixtures of sodium and potassium nitrates is less than the calculated value, thus confirming the view that the effect of dissolving one nitrate in another is to decrease the dissociation. The fluidity, or reciprocal of the viscosity, of the salts is directly proportional to the temperature, whilst the ratio of specific conductivity to fluidity decreases regularly with rise of temperature. The ratio of fluidity to molecular volume or molal fluidity and the ratio of equivalent conductivity to molal fluidity are also considered. T. H. P.

509. *Detection of Ozone, Nitrogen Peroxide, and Hydrogen Peroxide in Gas Mixtures.* **E. H. Keiser** and **L. McMaster.** (Amer. Chem. Journ. 39. pp. 96–104, Jan., 1908.)—The authors discuss the applicability of various reagents proposed for the detection of these gases, with special regard to the researches of Arnold and Mentzel, and of F. Fischer and Marx. Most of the reactions are not sufficiently characteristic. They find, however, that potassium permanganate, even in very dilute solution, is not decolourised by ozone, while NO_2 and H_2O_2 at once reduce the permanganate. Ozone and H_2O_2 are decomposed when passed through a tube containing powdered manganese dioxide, while NO_2 passes through unchanged. NO_2, on the other hand, passed through pure caustic soda gives with sulphurilic acid and α-naphthylamine the nitrate reaction; the presence of the two other gases is immaterial. Hydrogen peroxide finally colours a brownish solution of potassium ferricyanide and ferric chloride green and later blue. These combined tests are applied to the examination of the gases produced by burning hydrogen in air, by the silent discharge, by the action of concentrated sulphuric acid on barium dioxide, by the slow oxidation of phosphorus on moist air, by the flaming arc, and to the examination of atmospheric air. H. B.

510. *Landolt's Experiments on Change of Weight in Chemical Transformation.* **T. H. Laby.** (Chem. News, 97. pp. 1–3, Jan. 3, 1908.)—A summary of Landolt's work is given [see Abstract No. 789 (1906)]. It is pointed out that the greatest difficulty in accepting the observed alterations in weight of the reacting substances (as indicated to the author by Poynting) is the want of proportionality between the masses of the interacting substances and the observed changes in weight. For example, in two experiments in which 63·5 gm. of Ag were precipitated by the interaction of silver nitrate and ferrous sulphate, the losses in weight were 0·199 and 0·079 mgm. respectively, the error of experiment being not more than 0·015 mgm. If, however, the figures for a set of ten experiments on the above reaction are carefully compared, it is found that the want of proportionality is not so great as it appears to be at first sight. T. S. P.

511. *Solution in Alcohol-Water Mixtures.* **E. Cuno.** (Deutsch. Phys. Gesell., Verh. 9. 23. pp. 735–738, Dec. 15, 1907. Ann. d. Physik, 25. 2. pp. 346–376, Feb. 7, 1908. Extract of Inaugural-Dissertation, Erlangen, 1907.)—Experiments were made to determine the composition of the two liquid layers which are formed when certain salts are dissolved in a mixture of alcohol and water. The salts employed were potassium carbonate and manganese sulphate. The densities of the two layers were determined in a special form of the Sprengel-Ostwald pyknometer, and the amount of salt in each layer was estimated, the potassium carbonate by titration, the manganese sulphate by evaporation. The alcohol in the two layers was determined by the conductivity. Temperature had comparatively little influence upon the composition and formation of the layers. The critical solution—*i.e.*, the solution when both layers merged into one another—had the same composition for the three temperatures 25°, 40°, and 60° at which the experiments were made. The expression due to Bodländer, $W/\sqrt[3]{S}$, and also that due to Hertz and Knoch, $(S+A)W/S+A+W$, where A, W, and S are the quantity of alcohol, water, and salt respectively in 100 c.cm. of solution, give a fairly good constant. F. J. B.

512. *Anomalous Mobilities of Rare Ions.* **J. Roux.** (Comptes Rendus, 146. pp. 174–175, Jan. 27, 1908.)—The monovalent ions, except H and OH, have mobilities approaching 67. The divalent ionic mobility is about 48. The trivalent negative ions have a mobility lying between 82 and 90. The positive trivalent ions are difficult to measure, but the author has succeeded in measuring the mobilities of the ions of some rare earths. He obtained the following mobilities from centi-normal solutions: La 111, Yt 115, Ce 112, Gd 91, Sm 66. These, except the last, are unexpectedly high. The feeble mobility of samarium suggests a new method of separating it by diffusion from the other rare earths, a process which has hitherto been very difficult. As regards the temperature-coefficient, the mobility of lanthanum is 111 at 18°, and 181 at 25° C., a change of 8 per cent. per 1°. E. E. F.

513. *Synthesis by Means oj the Silent Electric Discharge.* **S. M. Losanitsch.** (Ber. Deut. Chem. Gesell. 40. pp. 4656–4666, 1907. Chem.

News, 97. p. 48, Jan. 24, 1908. Abstract.)—Under the influence of the silent electric discharge SO_2 is converted into $SO_3 + S$, and together with H or H_2S into $H_2O + S$; NO alone yields $N_2O_4 + N$; with H, NH_4NO_3; with H_2S, $H_2O + S + N$; while $N + H_2S$ give $(NH_4)_2S_4$; CS_2 alone is polymerised into a brown mass $(CS_2)_n$; in the presence of H or H_2S it gives $8CS_2 . 2H$; with CO, $8CS_2 . 2CO$; with C_2H_4, $5CS_2 . 2C_2H_4$; and with C_2H_2, $8CS_2 . 2C_2H_2$. Acetylene furnishes two products, one a viscid liquid, soluble in alcohol and ether, the other a yellowish-brown solid, insoluble in all solvents. These both give off an emanation which oxidises KI with liberation of iodine, and acts on a photographic plate through several thicknesses of Al- or Au-foil. It does not ionise air, and is not radio-active, but is due to absorbed oxygen, present in a labile state. Acetylene condenses also with H, CH_4, C_2H_4, CO, H_2S, and SO_2. W. H. Sr.

514. *Action of the Silent Discharge on Damp Methane.* **W. Löb.** (Ber. Deut. Chem. Gesell. 41. 1. pp. 87–90, Jan. 18, 1908. Chem. News, 97. p. 96, Feb. 21, 1908.)—The publication by Losanitsch of a second paper on electrosyntheses [see preceding Abstract] induces the author to make this preliminary communication. When methane saturated with water is exposed to the silent discharge, a white substance is deposited on the glass walls of the electrisator. This substance resembles the ice-flowers which form on window-panes; it is insoluble in all solvents, has the formula $C_9H_{15}O$ (or a polymer), and contains traces of silica, due to the attack of the glass; there is no indication of burning. Methyl esters of higher aliphatic acids, probably butyric acid, are also formed. Their formation is not surprising, since moist methane gives CO and H_2, which with the water present yield H . COOH and higher compounds by the union of the ethylene residues. H. B.

515. *Formation o, Ozone by the Electric Discharge at Low Temperatures.* **E. Briner** and **E. Durand.** (Comptes Rendus, 145. pp. 1272–1274, Dec. 16, 1907.)—In the apparatus previously described [Abstract No. 922 (1907)] the authors have replaced the sparking bulb by an ordinary double-walled ozoniser, with which they have examined the action of the silent discharge on oxygen at low temperatures. At —78° C., 11 per cent. of ozone is obtained, 12 gm. of ozone being formed per kw.-hour. At —194°, the vapour pressure of ozone approaches zero, and oxygen can be converted into ozone to the extent of 99 per cent. When the mean pressure is diminished from 208 mm. to 98 mm., the yield of ozone per kw.-hour rises to 55 gm., whilst further diminution of the pressure is accompanied by a decrease of the yield; the ozone condenses as it is formed to a deep blue, viscous liquid. The optimum pressure (98 mm.) is about the same as has been observed in the action of the spark discharge on the mixtures $N_2 + 2O_2$ and $N_2 + 8H_2$ and in the formation of oxides of nitrogen by the electric arc. The action of the spark discharge on oxygen at —194° only yields 0·79 gm. of ozone per kw.-hour, and this quantity is probably to be attributed to the action of the silent discharge always accompanying the spark. T. H. P.

516. *Utilisation of Metal Turnings.* **T. Watanabe.** (Coll. Sci. and Engin., Mem. Kyôto, 1. 8 pp. 188–186, 1906–1907.)—In the manufacture of armatures and other parts of electrical machinery, lathe-turnings of various alloys containing copper, tin, antimony, and lead are produced in large amounts. The author has undertaken laboratory experiments with a view to finding an electrolytic process and method for separating these metals. The turnings were first melted in order to obtain a homogeneous alloy; this contained, in per cent., 56·10 Cu, 33·94 Sn, 3·36 Sb, and 3·23 Pb. Iron and zinc were also present in small amounts. The alloy was employed as anode in an alkaline electrolyte with a kathode of lead oxide, but the solution of the tin and antimony, which was expected to occur without the aid of any external current, was too slight to render the method practicable. An attempt was then made to separate the metals composing the alloy by roasting this with galena, and converting the copper and tin into the corresponding sulphides, which were then to be extracted from the melt by a sodium sulphide solution. The separation of the copper and tin by this method was not quite complete, but the experiments proved that it was a practicable procedure, although it did not appear to offer any great advantages over the "liquation" process, now generally used for dealing with alloys of this kind. This method of separation, in fact, yields the white metal and the red alloy in their original form and purity with only a slight loss. The author's only reason for publishing his results with alternative methods is that these may prove of scientific interest, although not of practical value. J. B. C. K.

517. *Electrochemical Equivalent and Temperature.* **F. Kohlrausch** and **R. H. Weber.** (Deutsch. Phys. Gesell., Verh. 9. 22. pp. 681–696, Nov. 30, 1907.)—In order to ascertain whether electrochemical equivalents vary with the temperature, the authors have studied the action of a current on solutions of various salts contained in U-tubes, the lower portions of which were cooled and the upper portions heated, indicators being added to show any liberation of ions at the surface of separation of the hot from the cold solutions; to prevent convection currents at the separating surface, the solutions were gelatinised by means of arrowroot. In all cases negative results were obtained, so that the variation of the electrochemical equivalent with temperature is inappreciable. T. H. P.

518. *Electrolytic Reduction of Formic Acid.* (U.S. Pat. 867,575. Electrochem. Ind., N.Y. 5. p. 505, Dec., 1907. Abstract.)—C. Ellis and K. P. McElroy reduce formic acid, which they add to the 10 per cent. sulphuric acid of the kathode compartment of a diaphragm cell. The reduction is secondary and due to the H-ions, which act in two ways. Either the oxygen of the carboxyl group is replaced and methyl alcohol formed, or the hydroxyl is replaced and formaldehyde produced; a high current density favours the former, a low current density the latter process. The two products are obtained by distilling the acid of the kathode compartment, the acid being then returned. Cerium salts are used as catalysers. The kathodes are made of lead, spongy nickel-iron, or cobalt. H. B.

519. *Significance of so-called Alternating-current Passivity.* **A. Löb.** (Zeitschr. Elektrochem. 13. pp. 789–790, Dec. 6, 1907.)—It has been previously found that by suitable treatment of copper electrodes, the amount of copper dissolved from the latter, when they are immersed in potassium cyanide solution and an alternating current passed between them, may be diminished. This action has been ascribed to a passive condition of the copper, but the author shows that it can be readily explained on the assumption of supertension phenomena. The character of the electrode surface determines the ease of liberation of hydrogen, which decreases, whilst the copper liberated consequently increases, as the supertension increases. With zinc electrodes, which have a higher supertension, the so-called alternating-current passivity is more marked, whilst with nickel its extent is less. The differences between the electrode losses for crystalline and polished or ignited metals are not constant, but diminish with decreasing frequency of alternation, the conversion of the metallic ions into complex ions taking place to a greater extent.

T. H. P.

520. *Electrolytic Reduction of Hydroxylamine at Copper Kathodes.* **J. Tafel** and **H. Hahl.** (Zeitschr. Anorg. Chem. 56. 4. pp. 375–384, Jan. 18, 1908. Chem. Inst. d. Univ., Würzburg.)—Tafel had found [see Abstract No. 1768 (1902)] that when nitric acid was reduced at copper kathodes under such conditions that ammonia was produced to a large extent, reduction of hydroxylamine sulphate could not be detected. On the other hand, Flaschner [Abstract No. 1261 (1907)] had observed the reduction of hydroxylamine at copper kathodes. In the present communication the authors show that the discrepancy is due to the different experimental conditions. Flaschner worked with a 0·5 per cent. solution of hydroxylamine sulphate in normal sulphuric acid and a current density of 0·00025 amp./cm.^{2}, whereas Tafel used a 10 per cent. solution of hydroxylamine sulphate in 20–50 per cent. sulphuric acid and a current density of 0·24 amp./cm.^{2}. It is shown that a reduction of hydroxylamine to ammonia always takes place at a copper kathode if the layer of solution in contact with the kathode falls below a certain concentration with respect to sulphuric acid; this was always the case in Flaschner's experiments, but not in Tafel's. T. S. P.

521. *Electrolytic Determination of Minute Quantities of Copper.* **E. E. Free.** (Journ. Phys. Chem. 12. pp. 28–29, Jan., 1908. Paper read at New York Meeting of the Amer. Electrochem. Soc.)—Using a small Pt spiral as kathode the author obtains fairly good quantitative results from solutions containing as little as 0·05 mgm. Cu. The electrolyte consists of 2–4 per cent. nitric acid and a few drops of sulphuric acid to about 25 c.cm. solution; the electrolysis is continued overnight with 1·8 volts and 0·01 amp. Organic matter, dissolved in the disintegration of a filter paper by nitric acid, will prevent good deposits, but this difficulty may be overcome by making a preliminary deposition on a Pt dish in the usual way, dissolving the deposit and re-precipitating on the spiral electrode. T. S. P.

522. *Relation of Electroplating to Electrolytic Analysis.* **W. D. Bancroft.** (Journ. Phys. Chem. 12. pp. 36–46, Jan., 1908.)—The general results of this paper may be summed up as follows: (1) Cyanide and sulphate baths are used both for electroplating with copper and for the electrolytic determination of Cu. The acid ammonium oxalate and acid phosphate baths are used only for the electrolytic determination of Cu, but could be used as plating solutions. That the cyanide solution can be used for the electrolytic determination of Cu is made possible by the electrolytic oxidation of the cyanide at the Pt anode. (2) Cyanide baths are used both for electroplating with silver and for the electrolytic determination of Ag. A nitrate solution is used for the electrolytic determination only, since the deposited Ag is too coarsely crystalline for plating purposes unless a very high current be used or a colloid added. (3) Cyanide and sulphocyanate are used both for electroplating with gold and for the electrolytic determination of Au. Ferrocyanide solutions are used as plating baths, but present no advantage over the cyanide

and sulphocyanate from an analytical point of view, and therefore have not been studied with this in mind. Sodium gold sulphide solutions are used for electrolytic determinations, but the possibility of their forming a sulphide film of baser metal seems to make them objectionable for plating baths. (4) Nickel can be determined electrolytically in an ammoniacal solution, an ammonium oxalate solution, or an ammoniacal phosphate solution. Only a sulphate solution is used for plating. An oxalate solution would not corrode the anode, while a cyanide solution would be too difficult to regulate. A phosphate solution could probably be used for plating. (5) There is no relation between the plating and the analytical solutions with tin, plating being done with an alkaline stannate solution, while ammonium oxalate and ammonium sulphide solutions are used for electrolytic analysis. It is possible that plating could be done with an oxalate solution, and that tin could be determined analytically in an alkaline solution. (6) Cyanide, sulphate, zincate, and chloride solutions are used in plating with zinc. The first three are also used for electrolytic analysis. Zinc is also determined electrolytically in an oxalate solution which would probably work well as a plating bath. (7) Chlorides are not permissible in solutions for analysis on account of the danger from chlorine, hypochlorites, and hypochlorous acid. If a depolariser for chlorine, *e.g.*, toluene, xylene, or silver, is used the difficulties disappear, except perhaps in some determinations of Cu. (8) A great deal more experimental work needs to be done before we understand all the problems connected with electroplating and electrolytic analysis, but the general principles seem to be fairly well established. T. S. P.

523. *Electrolytic Reduction of Indigo.* **H. Chaumat.** (Comptes Rendus, 145. pp. 1419–1421, Dec. 30, 1907.)—Blue indigo may be readily reduced by electrolysis. The powdered indigo is mixed with slightly coarser graphite, and attached, in a cloth bag, around a carbon core, this constituting one electrode, which is connected with the negative pole of a battery and immersed in an aqueous solution of sodium carbonate or some salt of an alkaline earth. The anode is placed in a separate compartment of the voltameter, a concentrated solution of white indigo being obtained around the kathode. Sulphites, bisulphites, or even sulphates of the alkalies or alkaline earths absorb the oxygen evolved at the anode more readily than does white indigo, hence in their presence the use of any diaphragm separating the anode from kathode may be dispensed with. W. H. Si.

524. *Preparation of Chlorplatinic Acid by Electrolysis of Platinum Black.* **H. C. P. Weber.** (Bureau of Standards, Bull. 4. pp. 365–367, Jan., 1908. Amer. Chem. Soc., Journ. 30. pp. 29–31, Jan., 1908.)—Platinum black, made by reducing a platinum solution with zinc or alkaline formate and then warming with dilute hydrochloric acid to remove iron, is made the anode of an electrolytic apparatus containing HCl. A divided cell is used, the Pt sheet kathode being contained in a porous pot. The apparatus is so arranged that the solution of chlorplatinic acid, which is specifically heavier than the remainder of the solution, is siphoned off as it is formed. In concentrating the solution so obtained chlorine is passed through it for a time, thus ensuring freedom from any platinous compounds which may have been formed during the electrolysis. The solution prepared in this way is free from nitric acid.

T. S. P.

REFERENCES.

525. *Choice of Most Probable Value for an Atomic Weight: Atomic Weight of Hydrogen.* **W. A. Noyes.** (Amer. Chem. Soc., Journ. 30. pp. 4–8, Jan., 1908. Chem. News, 97. pp. 58–59, Jan. 31, 1908.)

526. *Atomic Weight of Tellurium.* **H. B. Baker** and **A. H. Bennett.** (Chem. Soc., Journ. 91. pp. 1849–1861, Nov., 1907.)—Includes an account of attempts to separate Te by fractional electrolysis.

527. *Case-hardening of Mild Steel.* **C. O. Bannister** and **W. J. Lambert.** (Iron and Steel Inst., Journ. 75. pp. 114–119, 1907. Mech. Eng. 20. pp. 508–510, Oct. 12, 1907. Metallurgie, 4. pp. 746–748, Nov. 8, 1907.)—Photomicrographs of a series of soft and quenched case-hardened steels confirm the fact that steel cannot be supersaturated with carbon below 871° C. The authors consider the "solid solution theory" to be capable of giving the best explanation of the carbon diffusion. F. C. A. H. L.

528. *Hardening of Steel.* **L. Demozay.** (Iron and Steel Inst., Journ. 75. pp. 144–178; Discussion and Correspondence, pp. 179–189, 1907. Engineering, 84. pp. 575–576, Oct. 25, and pp. 603–606, Nov. 1, 1907. Metallurgie, 4. pp. 726–742, Nov. 8, 1907.)—[See Abstract No. 192 (1906).] F. R.

529. *Copper Steels.* **P. Breuil.** (Iron and Steel Inst., Journ. 74. pp. 1–78, 1907. Carnegie Research Report. Mech. Eng. 19. p. 744, May 25, 1907. Abstract.)—[See also Abstracts Nos. 1480 and 1928 (1906).] F. R.

530. *Remarks on Photo-chemical Effects.* **E. Warburg.** (Deutsch. Phys. Gesell., Verh. 9. 24. pp. 753–757, Dec. 30, 1907.)—A discussion, on thermodynamic lines, of photochemical actions of the second class, *i.e.*, those in which an increase of the free energy results (ozone, &c.). L. H. W.

531. *Solubility of Calcium Carbonate in Aqueous Solutions of Potassium Chloride and Potassium Sulphate at 25°.* **F. K. Cameron** and **W. O. Robinson.** (Journ. Phys. Chem. 11. pp. 577–580, Nov., 1907.)—[See also Abstract No. 907 (1902).]

532. *Dissociation Temperatures of the Manganese Oxides in Air and in Oxygen.* **R. J. Meyer** and **K. Rötgers.** (Zeitschr. Anorg. Chem. 57. 1. pp. 104–112, Jan. 25, 1908. Wissenschaftl.-chem. Laborat., Berlin, N. Dec., 1906.)

533. *Analysis of White Metals and similar Alloys.* **E. Schürmann** and **W. Scharfenberg.** (Königl. Materialprüfungsamt, Mitt. 25. 5. pp. 270–274, 1907.)—The analysis is carried out by ordinary chemical methods, except that the antimony is deposited electrolytically from a solution of the thio-salt. T. S. P.

534. *Electrolytic Dissociation of Fused Salts.* **R. Lorenz.** (Ber. Deut. Chem. Gesell. 40. pp. 3308–3311, 1907.)—A criticism of Arndt's conclusions [see Abstract No. 1739 (1907)].

535. *Outlines of a New System of Thermodynamic Chemistry.* **G. N. Lewis.** Amer. Acad., Proc. 43. No. 7. pp. 259–293, Oct., 1907. Zeitschr. Phys. Chem. 61. pp. 129–165, Nov. 26, 1907. Translation.